UNIVERSITY OF CALIFORNIA

Santa Barbara

# Ancient Plant Use and the Importance of Geophytes among the Island Chumash of Santa Cruz Island, California

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy
in Anthropology

by

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September 2015

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July 2015

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DEDICATION

This dissertation is dedicated to my Family, Mike Glassow, and the Chumash People.

# ACKNOWLEDGEMENTS

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## PEER-REVIEWED PUBLICATIONS

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2012 Filling the Gaps: CA-SMI-274, a 10,500-Year-Old Shell Midden on San Miguel Island. *Journal of California and Great Basin Anthropology* 33(1):53-60.

Erlandson, Jon M., **Kristina M. Gill**, Torben C. Rick, and Leslie Reeder-Myers
2015 Three Late Paleocoastal Shell Middens on Santa Cruz Island, California. *PaleoAmerica* 1(1):113-115.

Erlandson, Jon M., Todd J. Braje, **Kristina M. Gill**, and Michael H. Graham

2015 Ecology of the Kelp Highway: Did Marine Resources Facilitate Human Dispersal from Northeast Asia to the Americas? *Journal of Island and Coastal Archaeology* 10(1):1-20.

**Gill, Kristina M.**

2013 Paleoethnobotanical Investigations on the Channel Islands: Current Directions and Theoretical Considerations. In *Human Interactions with the California Channel Islands*. edited by Christopher Jazwa and Jennifer Perry. pp, 113-136. University of Utah Press, Salt Lake City.

2014 Seasons of Change: Using Seasonal Morphological Changes in *Brodiaea* Corms to Determine Season of Harvest from Archaeobotanical Remains. *American Antiquity* 79(4):638-654.

**Gill, Kristina M.** and Jon M. Erlandson

2014 The Island Chumash and Exchange in the Santa Barbara Channel Region. *American Antiquity* 79(3):570-572.

VanDerwarker, Amber M., Dana N. Bardolph, Kristin M. Hoppa, Heather B. Thakar, Lana S. Martin, Allison Jaqua, Matthew E. Biwer, **Kristina M. Gill**

2015 New World Paleoethnobotany in the New Millennium (2000-2013). *Journal of Archaeological Research*. In Review.

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*Historical Dynamics*. Co-Principal Investigator for cultural resource services inventories and technical reporting according to CEQA, NEPA, and Section 106 of NHPA.

**Assistant Coordinator** **July 2010 to December 2012**

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**Associate Archaeologist** **September 2010 to March 2013**

*Central Coast Archaeological Research Consultants*. Research associate for cultural resource inventories and technical reporting according to CEQA, NEPA, and Section 106 of NHPA; Cultural resource site inspections and survey; Archival research and analysis; GPS data gathering and formal GIS mapping and analysis; Native American consultation.

**Laboratory Director** **September 2011 to March 2013**

*Department of Anthropology, University of California Santa Barbara*. Analysis of archaeological material excavated from SCRI-813, -814, and -619/620 during summer 2011. Responsible for directing the processing of collections and coordinating student interns in the laboratory.

**Principal Investigator** **Summer 2011**
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**Graduate Student Researcher** **September 2003 to May 2011**
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**Lecturer** **Summer 2009**
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*Department of Social Sciences, California Polytechnic State University San Luis Obispo.* Instructor for ANT 202 World Prehistory: Development of the diverse human cultures of both the Old and New Worlds from the emergence of the first human ancestors to the dawn of history; Biological evolution, global cultural development, and adaptations before the advent of writing. Lower division course.

**Lecturer** **Spring 2008**
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**Archaeologist** **June 2007 to June 2009**
*Applied EarthWorks, Inc.* Cultural resource inventories and technical reporting according to CEQA, NEPA, and Section 106 of NHPA; Cultural resource site inspections, surveys, excavation, and resource protection monitoring; Archival research and analysis; GPS data gathering and formal GIS mapping and analysis; Native American consultation.

**Archaeologist and Field School Supervisor** **September 2003 to July 2009**
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**Archaeologist and Field School Supervisor** **Summer 2007**
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**Environmental Analyst and Archaeological Technician** **February 2004-May 2007**
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**Archaeological Field School Student** **Summer 2003**
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## ORGANIZED SYMPOSIA

2015 *California's Islands: A Re-evaluation of their Perceived Marginality and the Implications for Archaeological Interpretation*. Symposium Chair, 80th Society for American Archaeology Annual Meeting, San Francisco.

2012 *Island and Coastal Archaeology*. Symposium Chair, 46th Society of California Archaeology Annual Meeting, San Diego.

2008 *Seeds, Nuts and Berries: Recent Paleoethnobotanical Investigations in California*. Symposium Chair, 42nd Society of California Archaeology Annual Meeting, Burbank.

## PRESENTATIONS AND PUBLIC LECTURES

2015 *Native Plant Use on the Northern Channel Islands.* Paper presentation in the Plenary Session, 38th Annual Conference of the Society of Ethnobiology, Santa Barbara, CA.

2015 *Gathering Evidence: Terrestrial Plant Resources of California's Islands.* **Kristina M. Gill** and Kristin M. Hoppa, 80th Society for American Archaeology Annual Meeting, San Francisco, CA.

2015 *Prehistoric Plant Use at Interior Sites on Santa Cruz Island: Evidence from Macrobotanical and Microbotanical Remains*. Kristin Hoppa and **Kristina M. Gill**, 80th Society for American Archaeology Annual Meeting, San Francisco, CA.

2013 *The Importance of Plant Foods Through Time: A View from Diablo Valdez, Santa Cruz Island*. Public Lecture, Santa Barbara County Archaeological Society, Santa Barbara Museum of Natural History.

2013 *Geophytes as an Important Food Source in the Channel Islands.* Paper presentation, 47th Society of California Archaeology Annual Meeting, Berkeley, CA.

2012 *Terrestrial Roots as an Important Food Source on the Channel Islands.* Poster presentation, 35th Annual Conference of the Society of Ethnobiology, Denver, CO.

2012 *The Importance of Plants on the Northern Channel Islands: Terrestrial Roots as a Highly Ranked Food Source.* Paper presentation, 46th Society of California Archaeology Annual Meeting, San Diego, CA.

2012 *The Diablo Valdez Site – Terrestrial Resource Exploitation among Maritime Hunter-Gatherer-Fishers*. Paper presentation, 77th Society for American Archaeology Annual Meeting, Memphis, TN.

2011 *Plant Exploitation in Island Interiors: Paleoethnobotanical Investigations at an Interior Bedrock Mortar Site*. Paper presentation, 76th Society of American Archaeology Annual Meeting, Sacramento, CA.

2011 *Modeling Small Seed Efficiency as a Food Source in the South Coast Range*. Karin Pitts and **Kristina M. Gill**, 76th Society of American Archaeology Annual Meeting, Sacramento, CA.

2010 *Paleoethnobotanical Investigations in the San Emigdio Hills*. Public Lecture, Santa Barbara County Archaeological Society, Santa Barbara Museum of Natural History.

2009 *Bedrock Mortars on Santa Cruz Island*. Two-Minute Paper presentation, 43rd Society for California Archaeology Annual Meeting, Modesto, CA.

2008 *Diablo Valdez (SCRI-619/620): Initial Investigations of Prehistoric Plant Use at a Bedrock Mortar Complex on Santa Cruz Island.* Paper presentation, 42nd Society for California Archaeology Annual Meeting, Burbank, CA.

## TECHNICAL REPORTS

Erlandson, Jon M., **Kristina M. Gill**, Torben C. Rick, and Todd J. Braje

2015 Racing the Rising Tide: Coastal Erosion, Archaeology, and Historical Ecology on Western Santa Cruz Island. Submitted to The Nature Conservancy, San Francisco.

Rick, Torben, Jon Erlandson, **Kristina Gill**, Leslie Reeder-Myers, and Todd J. Braje

2014 Rapid Archaeological Assessment on Santa Cruz Island: GIS Modeling, Sea Level Rise, and Archaeological Survey. Submitted to The Nature Conservancy, San Francisco.

Erlandson, Jon M., and **Kristina M. Gill**

2014 Archaeological Monitoring Report for the Bacara Consent Restoration Plan. Submitted to Tynan Group, Santa Barbara

**Gill, Kristina M.**

2015 Paleoethnobotanical Report for the Commonwealth Site, Menlo Park, CA. Submitted to Albion Environmental, Inc.

2014 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 59 Development Project, Hollister Ranch, Santa Barbara County. Submitted to Curtis Homes.

2014 Paleoethnobotanical Report for CA-SLO-536, Camp San Luis Obispo, SLO County, California. Submitted to Albion Environmental, Inc.

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2012 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 53 Development Project, Hollister Ranch, Santa Barbara County. Report submitted to Curtis Homes.

2012 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 77 Development Project, Hollister Ranch, Santa Barbara County. Report submitted to Curtis Homes.

2012 Cultural Resources Assessment for the East Cat Canyon 3D Seismic Survey Project, East Cat Canyon, Santa Barbara County, California. Report submitted to Padre Associates, Inc.

2012 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 108 Development Project, Hollister Ranch, Santa Barbara County. Report submitted to Curtis Homes.

2011 Paleoethnobotanical Report for CA-SLO-1778, Camp Roberts, San Luis Obispo County, California. Report submitted to Albion Environmental, Inc.

2011 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 17 Development Project, Hollister Ranch, Santa Barbara County. Report submitted to Curtis Homes.

2011 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 38 Development Project, Hollister Ranch, Santa Barbara County. Report submitted to Curtis Homes.

2011 Phase I Cultural Resources Assessment for the Hollister Ranch Lot 125 Development Project, Hollister Ranch, Santa Barbara County. Report submitted to Curtis Homes.

2011 Cultural Resources Assessment for the East Cat Canyon Exploratory Oil Well Project, East Cat Canyon, Santa Barbara County, California. Report submitted to Padre Associates, Inc.

2011 Cultural Resources Assessment for the East Cat Canyon 2D Seismic Survey, East Cat Canyon, Santa Barbara County, California. Report submitted to Padre Associates, Inc.

2008 Archaeological Survey Report: Replacement of Santa Rosa Bridge (51C-173), Santa Rosa Road and Avenue of the Flags in Buellton, Santa Barbara County, California. Applied EarthWorks, Inc. Report submitted to CalTrans District 5.

Bertrando, Ethan, **Kristina Gill**, and Karin Pitts

2011 Cultural Resources Study of the Proposed Firebreak Maintenance Project, Camp Roberts, California. Report submitted to the Office of Historic Preservation.

**Gill, Kristina M.** and John Dietler

2009 Cultural Resources Assessment for the SAC Wireless Cell Tower Project, Cambria, California. SWCA Environmental Consultants. Report submitted to San Luis Obispo County Department of Planning and Building.

2009 Cultural Resources Assessment for the SAC Wireless Cell Tower Project, Cuesta College, City of San Luis Obispo, California. SWCA Environmental Consultants. Report submitted to San Luis Obispo County Department of Planning and Building.

**Gill, Kristina M.**, Marc Linder, and Barry A. Price

2009 Cultural Resources Inventory for the City of Santa Maria Integrated Waste Management Facility, Santa Barbara County, California. Applied EarthWorks, Inc. Report submitted to Rincon Consultants.

## GRANTS AND AWARDS

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2012 Outstanding Student Paper Award, Society of California Archaeology. *The Importance of Plants on the Northern Channel Islands: Terrestrial Roots as a Highly Ranked Food Source* ($250)

2011 James A. Bennyhoff Memorial Grant, Society of California Archaeology. *Obsidian Exchange on the Santa Barbara Channel Islands: Correlating Obsidian Hydration Readings with Radiocarbon Dates from Well-Stratified Sties on Santa Cruz Island* ($1,500)

2011 Peter Paige Memorial Research Grant, UCSB Anthropology. *Excavation at the Diablo Valdez Bedrock Mortar Complex (SCRI-619/620), SCRI-813, and SCRI-814*. ($2,610)

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## ABSTRACT

Ancient Plant Use and the Importance of Geophytes among the Island Chumash of Santa Cruz Island, California

by

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Ancient plant use among the Island Chumash is much less well understood than other aspects of islander lifeways. There is a long history of research on faunal assemblages from Island Chumash sites, whereas comparatively little paleoethnobotanical research has been done. The resulting disparity in faunal vs. floral data combined with field observations of an island landscape ravaged by historical overgrazing, led various researchers to suggest that island plant foods were too marginal to support island populations and that mainland plant foods, subsequently, may have been a major motivating factor behind cross-channel exchange networks and increased sociopolitical complexity seen later in time. Within the context of optimal foraging theory and diet breadth models, I explore the significance of plant foods to the Island Chumash of Santa Cruz Island, using archaeological and paleoethnobotanical data from three sites with bedrock mortars, located in upland and interior areas. These non-coastal sites occur in some of the most productive terrestrial areas on the island, representing a range of time periods and site types: a logistical encampment (Sunburst – AD 1260-1500); an interior residence (Brodiaea Ridge, 4330 BC-AD 1630); and,

a village (Diablo Valdez, 3920 BC-AD 1800). Deep, well-stratified deposits and excellent preservation of domestic features (i.e., roasting pits, hearth clearing pits, structural floor) at Diablo Valdez provide a high-resolution record of archaeological and paleoethnobotanical remains, where I was unable to identify any significant change in plant food subsistence for nearly 6,000 years. Brodiaea corms were the most ubiquitous taxon identified at this site, sometimes occurring in great abundance and associated with large roasting pit features.

Here, I argue that carbohydrate content, rather than caloric value, may be a more appropriate currency for ranking plant foods in island contexts, where abundant marine resources provided ample fats and protein. In this scheme, the ranking of plant foods on the northern Channel Islands, in terms of optimal foraging and island archaeobotanical data (ranked high to low) are: 1) geophytes; 2) kelps and seaweeds; 3) small seeds; 4) fruits, berries, and non-toxic pits; 5) leaves, stems, and stalks; 6) toxic nuts and pits; 7) non-toxic nuts; and, 8) aquatic roots/rhizomes. While there is a preservation bias between these various plant food categories, this general ranking scheme appears to be supported in the island archaeobotanical record.

As Channel Island vegetation communities recover from more than a century of overgrazing, it has become clear that the phenomenally abundant geophyte resources that occur on the islands are significantly larger and denser than their mainland counterparts in the absence of gophers, moles, ground squirrels, deer, and other terrestrial herbivores. The brodiaeas are particularly well represented in archaeobotanical assemblages for the islands, used for at least 10,000 years and harvested in multiple seasons. The diversity and unparalleled abundance of island geophyte resources would have provided easily procurable and substantial carbohydrates for the Island Chumash and their ancestors. Combined with the

diverse and abundant edible marine plants and algae surrounding the islands, geophytes and other island plants provided the Island Chumash with ample food, medicine, and raw materials that were more abundant and stable than previously assumed.

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# ANCIENT PLANT USE AND THE IMPORTANCE OF GEOPHYTES AMONG THE ISLAND CHUMASH OF SANTA CRUZ ISLAND, CALIFORNIA: INTRODUCTION

The marine environment surrounding California's Channel Islands is extraordinarily productive and has long been seen as a primary draw for prehistoric people living on the islands for the past 13,000 years. Miles of rocky shorelines and sandy beaches surrounded by kelp forest support a diverse array of wildlife, from large pinniped populations to abundant fish and shellfish. A wide variety of edible seaweeds and kelps may also have been an attractive and abundant food resource (Erlandson et al. 2015a). The abundance and diversity of marine resources around the islands is evident in the material culture of island populations, from earliest documented human occupation around 13,000 years ago through the historic period.

Island terrestrial resources, in contrast, have long been dismissed by archaeologists as much less abundant and diverse, and therefore less important to island people compared with the mainland. Such characterizations date back to Spanish colonization, perpetuated by direct field observations of archaeologists, biologists, botanists and ecologists over the past century. Except for the last decade or so, the island flora was subjected to more than a century of overgrazing by introduced domestic animals (sheep in particular), with devastating effects. Field observations of these severely overgrazed islands led many previous researchers to view the terrestrial resources of the islands as largely depauperate, necessitating trade with the mainland for plant foods especially as population densities increased later in time (Arnold 2001, 2012; Arnold and Martin 2014; Kennett 2005).

Currently, after several years recovering from overgrazing, more recent field observations have noted a florescence of native island flora, many of which were important food sources for island people. Combined with the recent paleoethnobotanical research presented here, it has become increasingly apparent that terrestrial island plant food resources were more important than archaeologists once thought. Generally speaking, the diversity of island plant resources is lower when compared with the adjacent mainland, as has been pointed out by previous researchers (Jazwa and Perry 2013; Kennett 2005:51; Rick et al. 2005b). However, floral diversity is not the only factor in determining overall productivity of plant foods. The absence of certain animals (i.e., gophers, ground squirrels, and deer) prehistorically on the islands, while they were abundant on the mainland, would have resulted in lower resource competition on the islands for plant foods typically favored by these herbivores. Edible geophytes are particularly vulnerable to predation on the mainland by gophers, which preferentially target brodiaea corms as food over other resources (Hobbs and Mooney 1995; Proctor and Whitten 1971). In the absence of gophers, geophytes on the islands appear to have been significantly more abundant than they were on the mainland, providing a reliable source of carbohydrates. As the island flora continue to recover, we may find more instances of island plant foods that may have been more prolific than their mainland counterparts.

Although the Island Chumash and their ancestors had a decidedly maritime focus, the role of terrestrial plants, procured locally and/or through trade, and the use of milling equipment is the focus of this research. I chose Santa Cruz Island in particular because it is the largest and most floristically diverse of the Channel Islands, with presumably the most

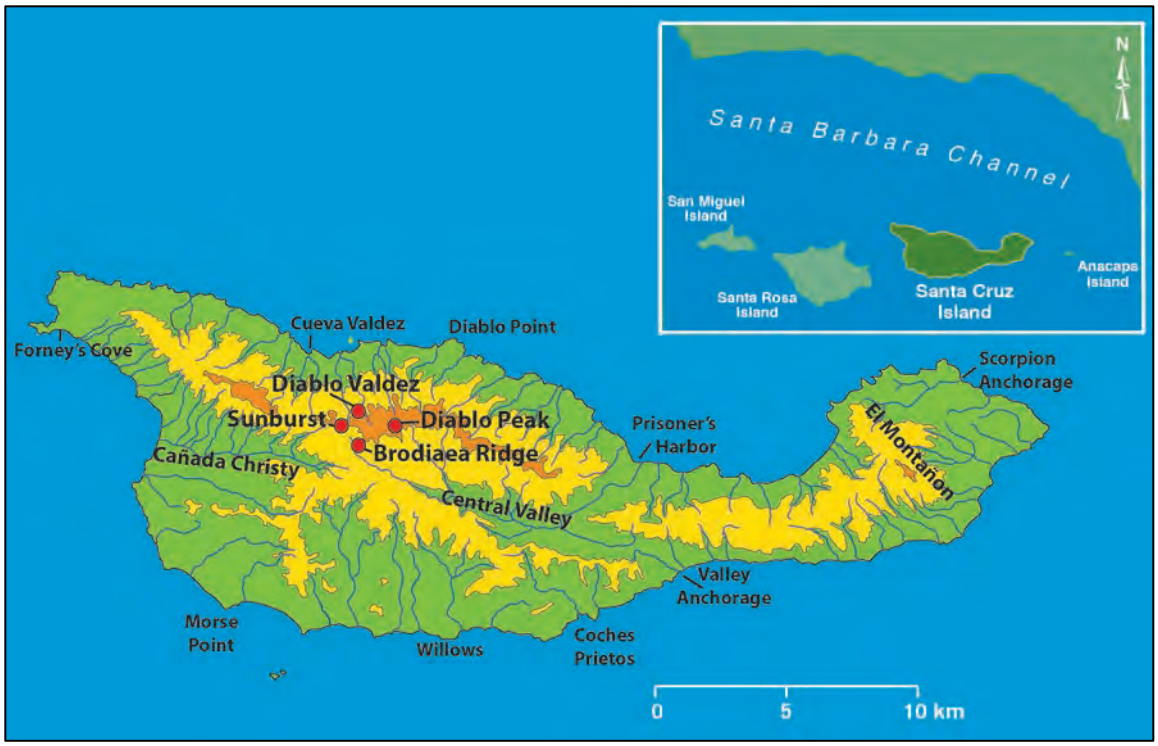


Figure 1.1. Map of Santa Cruz Island, Study Sites and Locations Mentioned in the Text. Yellow is Land Above 250 m and Orange is Land Above 500 m Elevation.

reliable sources of fresh water and plant foods (Jones et al. 1993:97). I investigated three sites in the course of my field research, all of which contain bedrock mortars: Brodiaea Ridge (CA-SCRI-814), Sunburst (CA-SCRI-813), and Diablo Valdez (CA-SCRI-619/620). Portable bowl mortars were also found at two of these sites (Brodiaea Ridge and Diablo Valdez), and all three are located away from the coast in upland or interior areas of the island. These bedrock mortar sites were chosen because of their presumed association with plant processing and their proximity to interior plant food resources such as acorns and pine nuts (Figure 1.1).

The Sunburst site is a largely single component shell midden with substantial evidence of bead manufacturing, dated to the Transitional and Late Periods (AD 1260-1500) (all dates presented in calibrated calendar years, expressed as either years before present (BP)

or years BC/AD). The Brodiaea Ridge site was occupied repeatedly over a longer time span, beginning ca. 6280 years ago and into the Late Period (~AD 1480-1630). Unfortunately, the radiocarbon dates and artifact assemblage from this site indicate the strata are mixed, inhibiting analysis of plant resource use through time. The Diablo Valdez site, in contrast, has excellent stratigraphic integrity, and excavations at two loci indicate repeated occupation from ca. 5870-5610 BP into the Protohistoric/Historic Period (AD 1640-1800). This large multi-component site also contains numerous domestic features, including roasting pits and house floors/depressions, suggesting that this was an interior village during much of its long occupational history. Framed within the context of optimal foraging and diet breadth models, the excavation data from these three sites with a focus on the paleoethnobotanical remains allows for a critical evaluation of terrestrial plant resource use on Santa Cruz Island over a time span of nearly 6,000 years, with implications for the role of plant foods in regional exchange networks of the Island Chumash and their neighbors.

**Theoretical Perspectives**

Previous paleoethnobotanical research on the Channel Islands has been limited and intermittent at best. However, available data indicate that archaeobotanical remains are present in many coastal and inland sites (Gill 2013; Hoppa 2014; S. Martin and Popper 2001; L. Martin 2010; Reddy and Erlandson 2012; Thakar 2014). Although understudied, these plant remains have the potential to make a significant contribution in understanding overall subsistence practices, settlement decisions, and regional exchange networks among the maritime oriented Island Chumash.

*Optimal Foraging*

Optimal foraging theory, and particularly diet breadth models, have been applied extensively to hunter-gatherer subsistence studies, and research on the Channel Islands is no exception (Bettinger 2001; Bettinger et al. 1997; Bettinger and Baumhoff 1982; Broughton 1997; Erlandson 1991; Jochim 1976, 1981; Kennett 2005; Kennett et al. 2008; Simms 1987; Wohlgemuth 1996). However, despite ethnographic and archaeological data indicating the importance of plants in prehistoric diets for most areas of the world (Kelly 1995), prevailing subsistence research on the Northern Channel Islands has focused heavily on marine resources (e.g., Colten 1995; Colten and Arnold 1998; Erlandson 1997; Glassow 2005; Glassow et al. 2008; Kennett 2005; Rick 2007; Sharp 2000). While it is apparent that island populations had a decidedly maritime focus, the role of plants, procured locally and possibly through trade, has yet to be examined thoroughly. It is important to address this line of evidence systematically, and foraging theory provides a framework for doing so.

Although resource ranking in terms of optimal foraging has been applied extensively in California archaeology to meat resources (e.g., Braje et al. 2007), plant resources have not been given the same consideration until recently. Wohlgemuth (2010) ranked plant resources in California, based on ethnographic and experimental data from the Great Basin and Columbia Plateau. While Wohlgemuth recognized that the precise values of return rates may not translate directly for California resources, the order of ranking should not change significantly. Simms (1987:38,42) has conducted experiments suggesting that ranking in terms of morphological characteristics is applicable cross-culturally. The general ranking of California plant resources in terms of return rates (kcal/hr) following Wohlgemuth (2010:60-61) is presented in Table 1.1.

Table 1.1. Ranking of California Plant Food Resources Based on Wohlgemuth (2010)

| Rank | Resource Class | Example |
|---|---|---|
| 1 | Geophytes | Brodiaea (*Brodiaea* spp.), Blue Dicks (*Dichelostemma* spp.), Ithuriel's Spear (*Tritelia* spp.), Mariposa Lily (*Calochortus* spp.) |
| 2 | Non-Toxic Nuts/Pits | Pine (*Pinus* spp.), Bay (*Umbellularia californica*), Hazel (*Corylus cornuta* var. *californica*), California Walnut (*Juglans* sp.) |
| 3 | Toxic Nuts | Acorn (*Quercus* spp.; *Lithocarpus* sp.), Buckeye (*Aesculus californica*), Wild Cherry (*Prunus ilicifolia*) |
| 4 | Small Seeds | Grasses (Poaceae), Red Maids (*Calandrinia* spp.), Chia (*Salvia columbariae*), Farewell-to-Spring (*Clarkia* sp.), Goosefoot (*Chenopodium* sp.), Native Barley (*Hordeum* sp.), Tarweed (*Hemizonia* sp.; *Madia* sp.) |
| 5 | Aquatic Rhizomes | Bulrush (*Scirpus* sp.), Cattail (*Typha* sp.) |

These plant food rankings are re-evaluated for the Channel Islands, where the diversity and abundance of plant food resources varies significantly from floral communities on the mainland. For instance, acorns and pine nuts, while present on the islands and adjacent mainland, are far more abundant in central California, where they may rank higher overall compared with other available plant foods in that region. In contrast, some food plants that are seasonally abundant and require little to no processing, such as prickly pear cactus (*Opuntia* spp.) and lemonade berry (*Rhus integrifolia*), are more abundant in southern California and on the islands than in other areas of California and the Great Basin. These disparities are discussed in more detail in Chapter 3, where plant food resources more common in southern California and particularly on the islands are incorporated into Wohlgemuth's initial ranking scheme, and re-evaluated using island archaeobotanical data in Chapter 7. Overall, the proposed ranking of California plant resources is useful in developing hypotheses and expectations for plant resource use on the northern Channel Islands through time, but the plant resource ranking needs to be adapted for the unique plant communities that occur on the islands (see Chapter 3). Here, I propose a revised island plant food ranking

scheme based on carbohydrate content, seasonal availability, and processing costs, that is then evaluated using paleoethnobotanical data from island sites (see Chapters 3 and 7).

*Diet Breadth*

Stemming from optimal foraging theory, diet breadth models are useful in that they examine search costs versus pursuit and handling costs, where search costs are directly related to resource density, and pursuit and handling costs are dependent on resource type (Bettinger 1991; Kelly 1995; Winterhalder and Goland 1997). These expressions were developed primarily for animal resources, where "search," "pursuit," and "handling" costs make sense for a hunter searching for, encountering, pursuing, and butchering game. Plant resources, however, must be considered in a different light (O'Connell and Hawkes 1981; Simms 1987). First, search costs are determined by the amount of time it takes a forager to move from one patch of plant resources to another. Patches of plant resources are stationary, and typically only seasonally available. Unless a foraging group is new to an area, or environmental conditions change dramatically, it is reasonable to assume that foragers were familiar with the general locations of resource patches and their season of availability. Once a patch is encountered, "gathering" of a particular resource begins, with yields dependent on the rate of procurement (Kelly 1995; Simms 1987). The rate of procurement for each plant type can be highly variable, depending on the individual gatherer, density within each patch, the level of difficulty involved with collecting specific resources, technology, and/or environmental conditions (Bettinger 2001; Bettinger and Baumhoff 1982; Simms 1987). Handling time for plant resources is conceptually similar to animal resources: the amount of

time needed to process the resource into a useable form, which depends on the particular resource. Toxic nuts have higher handling costs than non-toxic nuts or pits, for instance.

Generally, foragers search for highly ranked resources first and upon encountering a lower-ranked resource, must decide to either pursue the encountered resource or continue searching. As highly ranked resources decline in abundance (due to a number of possible reasons such as seasonal availability, longer-term environmental change, over-predation, etc.), foraging efficiency for that particular resource declines, and the diet may expand to include lower-ranked resources (Bettinger 2001; Simms 1987). Alternatively, if a change, such as a technological innovation, increases the efficiency of pursuit and handling of a previously un-pursued or seldom pursued resource, that resource may become ranked highly enough to be included in or become important to the diet (Bettinger 2001; Bettinger and Baumhoff 1982; Winterhalder and Goland 1997). Thus, changes in diet breadth can reflect changes in technology, anthropogenic effects on local resource abundance, or cultural response to external factors such as environmental stress. For Islanders, trade with mainland people for plant resources not available or abundant on the islands may also affect such equations.

**Hypotheses and Test Implications Driving the Research**

My research focuses on the role of plant foods in the subsistence economies of the Island Chumash, relative to environmental and cultural factors. Using paleoethnobotanical and other archaeological data, I test two main hypotheses that address issues related to the role of terrestrial plants in Island Chumash subsistence, including: 1) the importance of plant foods in Island Chumash diets relative to marine resources; 2) the effects of environmental

stressors such as drought on island plant foods; 3) changes in plant food diet breadth; and, 4) the extent to which plant foods were incorporated into the regional trade networks.

*Hypothesis 1*

Because carbohydrates found mostly in plant foods are an important component of a well-rounded diet rich in animal proteins (Erlandson 1988; Noli and Avery 1988), highly-ranked plant resources such as geophytes and non-toxic nuts/pits are expected to supplement the marine diet, even during periods of high marine productivity. If periods of warmer seawater temperatures reduced the productivity of marine resources significantly, the expansion of diet breadth to include lower-ranked plant resources such as toxic nuts, small seeds, and aquatic rhizomes is expected.

*Discussion and Test Implications*

Despite high marine productivity, highly ranked plant resources are expected to supplement a marine diet to balance protein from fish, shellfish and sea mammal with carbohydrates (Erlandson 1988; Kelly 1995). Relatively warmer seawater temperatures in the Santa Barbara Channel occurred beginning in the Middle Holocene, likely reducing overall marine productivity (Glassow et al. 2007; Kennett and Kennett 2000; Kennett et al. 2007; Sharp 2000). The majority of identified sites on Santa Cruz Island occupied from 6500 to 5000 cal BP are located near the coast and contain abundant mussel and red abalone shells, which suggest high marine productivity. This is followed by the period between 5000 and 4000 cal BP, when red abalones appear to decrease in abundance from middens on Santa Cruz Island (see Chapter 2).

Mainland sites during this period show an increase in mortar and pestle technology and higher frequencies of projectile points. Glassow et al. (2007:200) suggested that "[a] decline in population after 5000 cal BP is apparently associated with an environmental shift not yet well understood." A shift towards interior settlement on the islands appears to have occurred during this time, until around 3000 cal BP, when the use of interior residential sites appears to decline and settlement shifted towards coastal village sites (Kennett 2005:169; Perry 2003; Perry and Glassow 2015). Kennett (2005:169) suggests that this shift from interior to coastal settlement was the result of "decreases in residential mobility, and overall reduction in foraging range, and a significant shift in the way plant foods were collected."

Although the deposits at the Brodiaea Ridge site are mixed, this site was occupied repeatedly beginning 6280-6000 cal BP until between 480 and 320 cal BP (AD 1480-1630). The location of this site in the Central Valley is within close proximity to open grasslands containing edible geophytes such as brodiaea corms, as well as scattered chaparral and coastal sage scrub. In addition, large stands of Bishop pine occur less than 400 m to the south, in the upper reaches of Cañada Christy and on the south-facing slopes of the Central Valley. Both geophytes and pine seeds are highly ranked plant resources in California that could have been easily exploited with minimal processing requirements. Test implications in support of Hypothesis 1 for Brodiaea Ridge are: 1) macrobotanical remains and groundstone residues should be comprised primarily of highly ranked resources such as geophytes and pine seeds; and 2) while no permanent water sources currently are obvious in the immediate vicinity of this site, the contribution of fog drip at this location may be high, particularly during summer months (see Chapter 2). This site may therefore have been occupied

seasonally, presumably for purposes of targeting highly ranked plant resources in interior settings, while focusing on the highly productive marine resources the remainder of the year.

Occupation at the Diablo Valdez site occurred repeatedly for nearly 6,000 years, with the majority of deposition occurring between 5870 and 3000 years BP, with occupation spanning into the Protohistoric/Historic period as well. The location of this site at high elevation (ca. 500 m asl) on the north-facing slope of the northern range is in close proximity to a permanent water source and open grasslands containing geophytes and small seeds, as well as island and coastal oak woodland containing dense stands of oaks and wild cherry. Dense patches of manzanita also occur nearby, particularly along the ridges immediately west and south of the site. Bishop pines occur in dense stands to the east of the site between Orizaba and Pelican Bay, although the nearest and most accessible stand is located near the upper reaches of Cañada Christy. Although far from the coast, the close proximity of highly ranked resources such as geophytes, manzanita berry pits, and pine seeds, combined with the availability of lower-ranked resources such as acorns, wild cherry pits, and small seeds, may have proved an attractive location for populations becoming increasingly sedentary, and/or expanding their diet breadth during periods of lower marine productivity. Test implications in support of Hypothesis 1 for occupation at Diablo Valdez are: 1) the macrobotanical assemblage and groundstone residues should be comprised of both high- and low-ranked plant resources during periods of lower marine productivity, with a narrowing of the diet to include only high-ranked plant resources during periods of high marine productivity; and 2) use of the site may have been short-term seasonally during periods of high marine productivity and long-term or even year-round for targeting the wide variety of plant resources available during periods when marine productivity was relatively low. The

presence of year-round water in the drainages immediately east and west of the site may have facilitated the use of this site as an interior residential base.

Test implications for the Sunburst site, occupied from ca. AD 1260 to 1500, in support of Hypothesis 1 are similar to the other two sites, with highly ranked plant food resources targeted regardless of marine productivity. Although olivella bead manufacturing occurred at this site, it is not located near the coast or near a chert source, suggesting that bead making was incidental to gathering plant foods. Therefore, plant remains from this site are expected to consist primarily of highly-ranked geophytes, manzanita berry pits, and pine seeds.

***Hypothesis 2***

If the regional exchange network linking the islands and mainland, especially after the emergence of the *tomol* around AD 500 and even more so during the Medieval Climatic Anomaly (ca. AD 1000-1300), resulted in the importation of significant amounts of plant foods from the mainland as suggested by some archaeologists and ethnohistoric records (Arnold 2001, 2012; Gamble 2008; Kennett 2005; King 1976), these plant foods should be represented in the archaeobotanical assemblage. Local island plant foods should continue to be collected, but with a focus on highest-ranked resources (i.e., geophytes), which should be targeted regardless of variation in marine productivity or changes in cross-channel transport efficiency (the *tomol*). If the Medieval Climatic Anomaly resulted in significant terrestrial environmental stress on the islands, we should see an increase in mainland plant foods and/or a significant widening of diet breadth to include lower-ranked plant foods that have higher collecting or processing costs.

*Discussion and Test Implications*

Ethnohistoric records regarding subsistence on the islands indicate that fish were consumed in very large quantities and plant resources (such as chia and acorns) were imported from the mainland to at least several large island village sites (Arnold 2001; King 1976; Munns and Arnold 2002; Timbrook 1993). Paleoethnobotanical work conducted by Martin and Popper (2001) also revealed that some plant resources were imported from the mainland, based on the presence of California walnut (*Juglans californica*), which does not occur on the islands today. Although many native island plant foods were likely extirpated from the islands during the historic ranching period, trees and large woody shrubs are more likely to have survived the effects of overgrazing. California walnut is a large shrub/small tree that grows up to 30 feet tall, and is common on the mainland, suggesting it may be a good indicator for importing a mainland plant food. It is important to note that all the sites considered by Martin and Popper (2001) postdate AD 600 and all are located adjacent to the coast on the west end of Santa Cruz Island except for one small sample from Prisoner's Harbor. Occupation at the Diablo Valdez site after AD 1300, the Sunburst site around AD 1300, and the Brodiaea Ridge site by at least AD 1500, indicate that interior sites were still in use during the Late Period, presumably for targeting plant resources. Although it is possible bedrock mortars at Diablo Valdez were also used earlier in time, numerous portable mortar fragments were found on the surface, suggesting these groundstone tools were heavily used during the latest occupation. In addition, olivella beads and bead-making detritus, deer bone, fused shale, and obsidian suggest that the occupants of Diablo Valdez participated in the regional exchange network at least to some extent.

Test implications in support of the importation of plants from the mainland and subsequent reliance on imported plant resources are: 1) the macrobotanical assemblages at all three sites should include a) plant resources neither found on the islands today nor easily extirpated, such as California walnut, and b) only highly ranked local plant resources such as geophytes, manzanita berry pits, and pine seeds, with limited evidence for lower-ranked local plant resources such as acorn and small seeds, even during periods of low marine productivity; and 2) the assemblage at Diablo Valdez should also include additional evidence for imported trade items such as large terrestrial mammal bone and exotic lithic materials such as obsidian. Alternatively, if importation of plant foods to the islands during the Late Period was not as extensive as the literature suggests, we should expect a macrobotanical assemblage consistent with Hypothesis 1, where highly-ranked resources are always targeted, and lower-ranked resources are incorporated into the diet primarily during periods of low marine productivity.

Archaeobotanical visibility for the local procurement of acorns versus importation to the island through trade is inherently problematic. Abundant oaks occur on Santa Cruz Island today, with ten different species (and an additional subspecies) represented (Junak et al. 1995). The high diversity of species within the proportionately small 249 square km area of the island has been cited as possible evidence for importing acorns from various places on the mainland to the islands (Timbrook 1993). Ethnographic information suggests that acorns could be imported to the islands in their shells, which facilitates short-term storage, or pre-shelled which reduces processing time for the island inhabitants (Fauvelle 2013; Munns and Arnold 2002; Timbrook 1993, 2007). The presence of acorn nutshell at any of the three sites included in the current study could indicate either trade or local procurement, with no way of

distinguishing the two based on acorn nutshell alone. If acorn nutmeats are present, while nutshell is largely absent, a stronger case for the importation of shelled acorns could be made. However, until we understand more about the nature of island acorn use, we cannot assume that acorns were imported from the mainland rather than processed elsewhere on the island, if nutmeats are found archaeologically.

*Organization of Dissertation*

In the chapters that follow, I discuss the environmental setting and distribution of marine and terrestrial resources on the Northern Channel Islands (Chapter 2), summarizing archaeological research on the Island Chumash, including a cultural chronology and current ideas about settlement patterns and regional exchange. In Chapter 3, I discuss prevailing assumptions about terrestrial plant food resources in the Santa Barbara Channel region, and the northern islands in particular, as well as previous paleoethnobotanical research. I then present the methods I used to obtain archaeological data from excavations at the three sites (Chapter 4), followed by the site descriptions and data recovered from them (Chapters 5 and 6). I then summarize the quantitative evidence for terrestrial plant use through time on Santa Cruz Island based on the paleoethnobotanical data recovered during my research (Chapter 7). The hypotheses driving this research are tested using these data, ultimately showing no significant change in the use of island plant foods through tine, and no evidence for the large-scale importation of plant foods from the mainland. In Chapter 8, I argue that these results point towards an island plant food resource base that remained productive and stable for 6000 years or longer, indicating the island plant communities may have been much more optimal foraging grounds than previously thought.

Throughout this discussion, I talk extensively about geophytes, and brodiaea in particular. The *Brodiaea* complex currently includes three closely related genera described as "*Brodiaea* sensu lato" (s.l.) (*Brodiaea* spp., *Dichelostemma* spp., and *Triteleia* spp.), and four "satellite genera" (*Androstephium* spp., *Bloomeria* spp., *Muilla* spp., and *Triteleiopsis* spp.) widely found in western North America (Gill 2014; Pires and Sytsma 2002:1342). These seven genera are morphologically similar with overlapping biogeographic ranges. Although the most likely candidate for the archaeobotanical corms recovered on the Channel Islands are blue dicks (*Dichelostemma capitatum*)—based on modern distribution, abundance, and overall fecundity—I refer to all taxa within the complex (*Brodiaea* s.l.) as brodiaea throughout.

# CHAPTER 2

# THE ISLAND CHUMASH AND ISLAND ENVIRONMENTS

## The Geography of the Islands off Southern California

The southern California Bight, between Point Conception and San Diego, is an important ecological transitional region between the cooler, wetter coastal areas to the north and the more arid conditions to the south. The coastlines north of Point Conception are subjected to heavy surf and prevailing westerly winds, while the coastal areas within the bight are much more protected from prevailing winds and swells due to the orientation of the coastline and presence of the offshore islands. The coastline in this region takes a dramatic turn from the north-south trending coast north of Point Conception to the predominately east-west trending Santa Barbara Channel area, and it curves back towards a north-south orientation further south near San Diego (Figure 2.1). The eight islands of the southern California Bight are generally grouped by the northern islands (San Miguel, Santa Rosa, Santa Cruz, Anacapa), which were connected as a single landmass known as Santarosae until around 9000 years ago (Clark et al. 2014; Kennett et al. 2008; Reeder-Myers et al. 2015), and the southern islands (Santa Barbara, San Nicolas, Santa Catalina, San Clemente), which are located further apart from one another and the mainland coast, and have always been isolated (Schoenherr et al. 1999).

At the time of European contact, the Island Chumash inhabited the northern islands, while the Island Tongva inhabited the southern islands (Gamble and Russell 2002; Rick 2007). The cultural chronology provided below focuses on the Island Chumash, because the

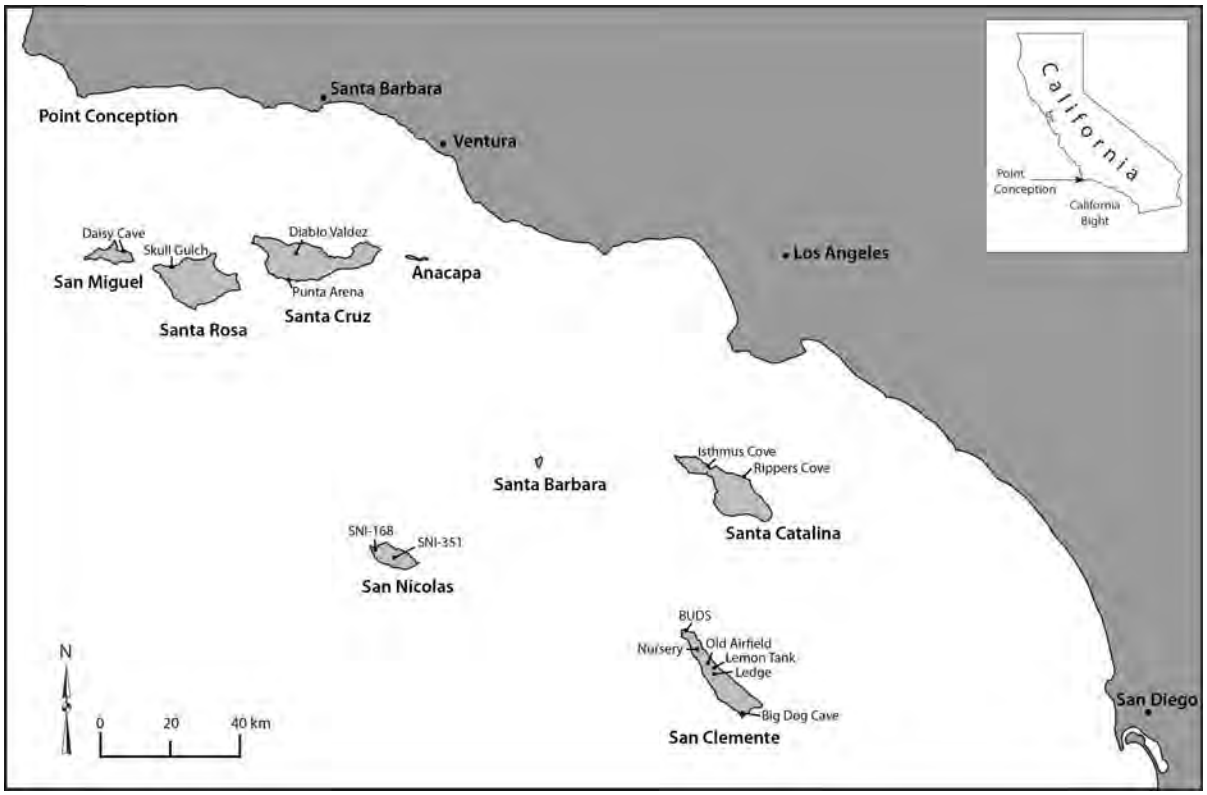


Figure 2.1. The Southern California Bight and Offshore Islands, Showing Locations of Sites Discussed in the Text.

northern islands are the focus of my research. However, the discussion of the marine and terrestrial island environments below includes all of the islands, as does the previous paleoethnobotanical research discussion in Chapter 3. The purpose of including all of the islands in these discussions is to show the potential significance of paleoethnobotanical work to our understanding of both the northern and southern island lifeways and regional exchange networks in Southern California.

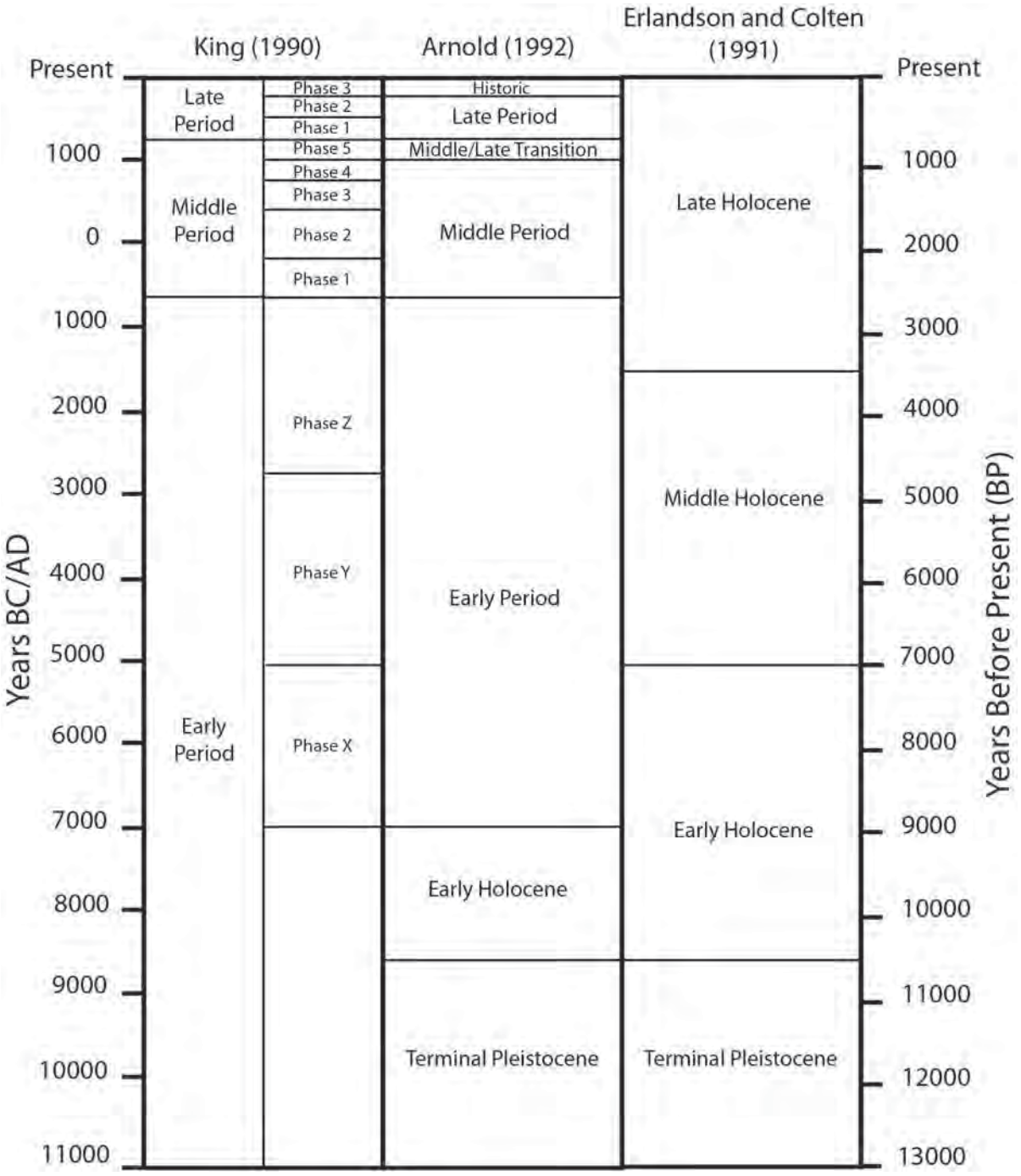


Figure 2.2. Cultural Chronologies Chart for the Northern Channel Islands

## The Island Chumash: Maritime Hunter-Gatherer-Fishers

### *Cultural Chronology for the Northern Channel Islands*

The regional cultural chronology for the Santa Barbara Channel area has been refined over decades of archaeological research, and will continue to be refined as archaeological research continues (e.g. Arnold 1992; King 1990; Olson 1930; Orr 1968; Rogers 1929). The currently accepted cultural chronology, including the historical ranching period, are discussed first, followed by a discussion of the modern marine and terrestrial island environments, assumptions about plant use in the region based largely on ethnographic information, and previous paleoethnobotanical research. Divisions of time discussed here generally follow Erlandson and Colten (1991) and Glassow et al. (2007), which allow for comparisons of regional cultural patterns through time without assigning a particular cultural period that may be contested by various researchers or may change as research progresses. Figure 2.2 presents a general chronological chart indicating the various cultural period schemes used by various researchers.

### *The Terminal Pleistocene/Early Holocene (13,000 to 7000 cal BP)*

Archaeological research over the last several decades in coastal areas along the eastern rim of the Pacific Ocean suggests that the earliest inhabitants of the Americas were well adapted to maritime environments. Indeed, the Coastal Migration Theory continues to gain support in the archaeological literature and the Kelp Highway Hypothesis argues for an early dependence on marine resources in or adjacent to kelp forests and the use of boats, facilitating a rapid dispersal of humans into the Americas (Erlandson et al. 2007, 2015a). The culture history of the Channel Islands play an integral role in developing and refining these

ideas, as the body of evidence for human occupation during the Terminal Pleistocene and Early Holocene continues to grow (Erlandson et al. 2007, 2011, 2015b; Johnson et al. 2002). Until around 9000 years ago, the four northern Channel Islands were connected in one large landmass, known as Santarosae (Clark et al. 2014; Reeder-Myers et al. 2015). The earliest evidence for people on the Channel Islands comes from human bones found at Arlington Springs on Santa Rosa Island, dated to approximately 13,000 cal BP (Johnson et al. 2002; Orr 1968). However, the most substantial evidence for occupation comes from various sites on San Miguel and Santa Rosa dated to ~12,000-8500 cal BP (Erlandson et al. 2011, 2015b). Described as Paleocoastal peoples, these early populations were adept in making fine chipped stone artifacts, including crescents, Channel Island barbed points (CIBs), and Amol points that are diagnostic of this time period (Braje et al. 2013; Erlandson 2013; Erlandson et al. 2011; Glassow et al. 2008; Gusick 2012; Rick et al. 2013). Chipped stone crescents, likely hafted as transverse points, were probably used for hunting birds, as some of these Paleocoastal sites contain abundant bird remains (Erlandson et al. 2011; Moss and Erlandson 2013).

While the majority of evidence for Paleocoastal occupation of the islands comes from San Miguel and Santa Rosa Islands, 12 Paleocoastal sites have now been identified on Santa Cruz Island, including three chipped stone crescent localities (Erlandson et al. 2015a; Glassow et al. 2007; Gusick 2012). Based on the number of Paleocoastal sites that have been documented on the islands to date, it appears that Paleocoastal populations may have been larger on the Channel Islands than previously thought (Rick et al. 2013). As noted by Erlandson et al. (2015b:115), "[t]his seems especially likely considering that the shorelines and coastal lowland habitats available at the time—landforms most likely to have been the

focus of Paleocoastal settlement—have been lost to rising seas and coastal erosion." Essentially, the Paleocoastal sites found on the islands today represent the use of the island interior at the time. It is reasonable to speculate that interior plant food resources were at least one motivating factor in this early interior settlement, in addition to lithic sources, fresh water, etc. (Erlandson et al. 2007).

*The Middle Holocene (~7000-3300 cal BP)*

After Paleocoastal occupation, sea levels continued to rise and the islands became increasingly separated, until ca. 7000 to 6000 years ago, when sea level rise slowed dramatically. Cool ocean temperatures indicating high marine productivity largely characterize the marine environment of the Middle Holocene (Erlandson 1994; Glassow et al. 1988; Glassow et al. 2007; Kennett 2005). Manos and metates dominate artifact assemblages from the mainland (aptly named the Millingstone Horizon, and extend back into the Early Holocene) along with relatively large amounts of burned rocks, possibly from pit ovens. Scraper planes are also commonly found at mainland sites of the southern reaches of the California Bight, possibly indicating yucca processing (King 1990; Kowta 1969; Salls 1985). Conversely, manos and metates are virtually absent from island assemblages of this period, suggesting that plant exploitation and processing was different than that on the mainland (see Chapter 3). Digging-stick weights (aka doughnut stones, see Chapter 3), however, are commonly found at Early Period sites on the islands (as well as at sites of later time periods), indicating that geophytes were exploited to at least some extent (Glassow 1996b; Sutton 2014a, 2014b).

As sea levels began to stabilize, significant changes to the nearshore marine environment occurred between 6000 and 4000 cal BP, a time interval marked by intermittently warmer ocean temperatures, resulting in periods of relatively low marine productivity (Glassow et al. 2007; Kennett 2005). The number of identified archaeological sites on Santa Cruz Island dated to between 6000 and 5300 cal BP appear to be located primarily adjacent to the coast, and they contain abundant red abalone shells, described as red abalone middens (Braje et al. 2009; Glassow 1993; Glassow et al. 2008; Sharp 2000). Two large sites of this period, Punta Arena (CA-SCRI-109) and El Monton (CA-SCRI-333), provide evidence for exploitation of the rich marine resources located adjacent to each site (Glassow 2005; Glassow et al. 2008; Sharp 2000; Wilcoxon 1993). Throughout the Middle Holocene, increasing occupation of the interior and higher frequencies of dental caries are evident on the islands. This pattern, combined with prevalent digging-stick weights, may reflect an increasing reliance on terrestrial plants on the islands, particularly geophytes (Conlee 2000; Glassow 1996b; Glassow et al. 2007; Kennett 2005; King 1990; Orr 1968; Rick 2007; Timbrook 1993; Walker and Erlandson 1986). On Santa Cruz Island, as the red abalone midden occupation apparently ended ca. 5300 cal BP, an increase in interior settlements occurs between ca. 5800 and 3000 cal BP, possibly indicating a shift towards terrestrial resources (Perry and Glassow 2015; Glassow 1993).

Although people continued to use manos and metates on the mainland at this time, mortars and pestles appear for the first time, signaling a change in technology, subsistence, and/or social organization (Glassow et al. 2007; Rosenthal and McGuire 2004). An important mainland site dating to this period is the Aerophysics Site (CA-SBA-53), where the assemblage consists of a number of mortar and pestle fragments, along with other indications

of a possible residential base (Glassow 1996b). Gamble and King (1997) suggest early mortars and pestles signal an important shift in subsistence towards acorn exploitation. Glassow (1996b), alternatively, suggests that while mortars and pestles may indicate a change in subsistence, it is possible they were used for processing starchy rhizomes of such plants as bulrush (*Schoenoplectus* spp.) and cattail (*Typha* spp.), rather than acorns (*Quercus* spp.). His hypothesis is based largely on the high frequency of mortars and pestles at the Aerophysics site and the site's environmental context at the Goleta Slough, where fresh and brackish water supported an easily procurable supply of wetland rhizomes, while dense stands of oaks are located further away (Glassow 1996b:18).

*The Late Holocene (3300 cal BP to AD 1542)*

Between 3000 and 2000 cal BP, apparent shifts in settlement and, presumably, subsistence, are noted, with an emphasis on coastal settlement and maritime orientation, and fewer interior settlements overall (Perry and Glassow 2015). By this time, mortars and pestles had been widely adopted on the mainland and likely the islands as well, and circular shell fishhooks were in use by ca. 2500 cal BP throughout the channel region (Glassow et al. 2007; Rick et al. 2005). Indications of increased cultural complexity are evident in the artifact assemblages on the islands and adjacent mainland, and regional exchange networks between the islands and the mainland became increasingly important (Erlandson and Rick 2002; Glassow et al. 2007; King 1990; Lambert and Walker 1991). Faunal data from mainland sites indicate use of both marine and terrestrial species (Erlandson and Rick 2002; Kennett 2005; Glassow 1985; 1996a), and mano/metate technology is largely abandoned in mainland coastal settings after ca. 2200 cal BP (Glassow 1996b). The increase in maritime

orientation on the islands, including increased sedentism along the coast, intensified fishing, and the growing regional exchange network, provide the basis for the development of socio-political complexity throughout the channel during later periods (Arnold 1992, 2001, 2010; Gamble 2002, 2008, 2011, 2012; Glassow et al. 2007).

Sea surface temperatures transitioned from moderately warm to cooler temperatures during this time (Kennett 2005). The introduction of bow and arrow technology around 1500 cal BP and the plank canoe, or *tomol*, soon after, had important implications for later time periods. A noticeable increase in large pelagic fish such as swordfish and tuna are apparent in archaeological assemblages of this period (Arnold and Bernard 2005; Gamble 2002; Glassow et al. 2007; King 1990). Several specialized groundstone manufacturing sites dating to this period, especially between 1350 and 1020 cal BP, have been identified on San Miguel Island (e.g., CA-SMI-503, -504, -525, -492) (Conlee 2000; Kennett and Conlee 1992; Rick 2007; Rozaire 1983; Walker and Snethkamp 1984). The evidence for groundstone manufacture on San Miguel Island may indicate craft specialization and participation in an expanding regional exchange network (Conlee 2000), facilitated by the production of shell bead money.

The socioeconomic complexity encountered by early European explorers along the Santa Barbara Channel emerged within the last 1000 years and continued to develop until Missionization (AD 1782). High marine productivity combined with a prolonged terrestrial drought known as the Medieval Climatic Anomaly (MCA) between 1200 and 600 years ago (AD 800 and 1400) may have caused environmental stress, which has been suggested as a prime mover for the development of this complexity (Arnold 1987, 1992, 2001; Glassow et al. 2007; Jones et al. 1999; Kennett and Kennett 2000; Lambert 1994; Raab and Larson 1997; Stine 1994). The extent to which various environmental stressors—including drought—drove

the development and/or solidification of Chumash complexity and the timing of these events has been debated by various researchers (see Gamble 2005).

Arnold (1987) argued for the emergence of a ranked society, increased use of regional exchange networks, and increased craft specialization between AD 1150 and 1300, a period she defined as the Middle/Late Transition. Her work has shown that post-AD 1200, island populations were manufacturing millions of shell beads with chert microdrills. These drills were primarily produced on the eastern portion of Santa Cruz Island and transported to other areas of the island for the manufacture of shell beads. The beads manufactured with these drills were exchanged with mainland populations for a variety of products such as obsidian, projectile points, bone tools, and many other goods (Glassow et al. 2007:207; King 1976; Munns and Arnold 2002; Timbrook 1993). Plant food resources, particularly acorns and small seeds, were also reportedly imported from the mainland, as described in early ethnographic accounts (see below; King 1976; Timbrook 1993).

Comparatively few archaeological sites have yet been dated to the Middle/Late Transition (Erlandson et al. 2001), but Arnold (1992) has suggested that several island sites were abandoned just prior to this period. Mainland sites dating to this period may be difficult to distinguish from earlier or later periods due to the high degree of bioturbation at multicomponent sites (Glassow et al. 2007), although a few have been identified along the mainland coast in Tecolote (CA-SBA-71) and Corral Canyons (CA-SBA-1731), Pitas Point (CA-VEN-27), and further north in Montaña de Oro State Park at Coon Creek (CA-SLO-9) (Erlandson et al. 2008; Erlandson and Gerber 1993; Erlandson and Rick 2002; Codding et al. 2009; Gamble 1983). King (1990) and Gamble (2004, 2005) argue that evidence for a ranked society and hereditary elites emerged earlier in time, prior to the Medieval Climatic

Anomaly, suggesting that these strategies may not have been driven by punctuated environmental stressors. Nevertheless, the regional exchange network articulating island, coastal mainland, and interior mainland populations became firmly entrenched after AD 1300, presumably acting as a security net for coping with drought and declines in terrestrial or marine productivity (Arnold 1987, 2001).

*The Protohistoric (AD 1542-1769) and Mission Period (AD 1769-1834)*

The Protohistoric Period in southern California is defined as the period of time between the earliest European maritime expeditions of Cabrillo in AD 1542 and the land-based voyage of Portolá. The ultimate result was the establishment of the Mission system beginning in AD 1769 and the widespread abandonment of native villages (Wagner 1929). The extent of contact and the effects of Old World diseases between these sporadic, relatively brief, and poorly documented early European maritime voyagers and native populations in southern California has been debated over the years. However, early epidemics may have had a significant impact on the Island Chumash, perhaps beginning with the extensive contact with Cabrillo and crew (Erlandson and Bartoy 1995). Analysis of Cabrillo's ship logs indicates his three ships were anchored in Cuyler Harbor on San Miguel Island for about eight weeks, implying extensive contact that may have facilitated the spread of Old World diseases to Island Chumash populations (Erlandson and Bartoy 1995). An analysis of 215 calibrated radiocarbon-dated sites on the northern Channel Islands suggests possible "shifts in settlement and demography consistent with large-scale population loss and/or village aggregation during the Protohistoric period…" (Erlandson et al. 2001:21). However, by the time of the Portolá expedition, the Island Chumash were clearly thriving,

suggesting that any effects of initial contact with Europeans may have been relatively short-lived. More research into this period of Chumash history is needed to understand more fully the effects of European contact before Missionization.

Gaspar de Portolá's land expedition, the first in California, passed through the Santa Barbara Channel region in AD 1769. Permanent Spanish settlement of the region began with the establishment of several missions and presidios in the area, including Mission San Luis Obispo de Tolosa in 1772, El Presidio Real de Santa Barbara and Mission San Buenaventura in 1782, Mission Santa Barbara in 1786, Mission La Purísima Concepción in 1787, and the Mission Santa Inez in 1804 (Costello and Hornbeck 1989). As seen elsewhere in California, induction into the mission system had a devastating effect on local native populations and economies. By around AD 1803, most mainland villages were abandoned (King 1990), although some island villages continued to exist until AD 1822, when the last of the islanders were removed to the mainland (Arnold 2001; Johnson 2001). The devastating effects of Spanish missionization on traditional Chumash lifeways are well documented in archaeological and ethnohistoric records (Johnson 1989). There is abundant evidence for continuity and cultural resilience of many aspects of Chumash society from the beginning of the Historic era into modern times, but the traditional Chumash way of life was forever changed. So too was the natural landscape of the Channel Islands.

*The Historic Mexican and American, Ranching, and Recovery Periods (AD 1834 to Present)*

The historic era brought many changes to the islands and the people who lived there. After Mexican independence the mission system was secularlized in 1834, and large tracts of land were given away as Mexican Land Grants. Ownership of the three largest islands (Santa

Cruz, Santa Rosa and Santa Catalina) remained in the hands of just a few ranching families. When California became a state in 1850, the other five islands, which were ungranted by the Mexican government, became US government property (Daily 2012). During this historic era, a variety of ranching endeavors took place, with many products shipped to the mainland for sale. On Santa Cruz, both sheep and cattle were brought to the island as early as 1855, and a sheep industry (for both meat and wool) dominated ranching efforts through the 1940s. By the early 1900s, as many as 55,000 to 100,000 sheep roamed freely around the island and were rounded up occasionally for shearing (Daily 2012; Junak et al. 1995). Related agricultural endeavors included growing hay and alfalfa, walnuts, almonds, and a variety of vegetables. Wine grapes were also a significant endeavor, with ten varietals of red and six of white grown and produced on Santa Cruz Island. By 1917, the Santa Cruz Island vineyard was the largest in Santa Barbara County, producing 83,000 gallons of wine at its height (Hussey 1961; Junak et al. 1995; Pinney 1994). By the time the Nature Conservancy purchased most of Santa Cruz Island in 1978, feral pigs and sheep had decimated the native island flora as a result of more than a century of overgrazing and consequent soil erosion. The sheep were systematically removed from the island in the 1980s, and the feral pigs were successfully removed in 2006 (The Nature Conservancy 2014).

Overgrazing by livestock during the ranching era affected the islands in significant ways. Not only did overgrazing decimate the native flora, the habitat disturbance also facilitated the spread of aggressive alien plants, particularly European annual grasses (Hochberg et al. 1980; Junak et al. 1995). Junak et al. (1995:38) summarized the ways in which overgrazing, especially by sheep and pigs, affected native plant communities:

> In grassland communities, sheep grazing has reduced herbaceaous cover, increased bare ground, altered community structure, decreased litter, and increased erosion

(Van Vuren and Coblentz 1987). Browsing by sheep in shrub communities altered growth forms and prevented regeneration in canopy species. Sheep completely defoliated some low-growing shrubs and reduced diversity of understory species (Hochberg et al. 1980; Van Vuren and Coblentz 1987). In the pine forest near Pelican Bay, sheep grazing after fire reduced foliar cover, regeneration, and species richness of the understory (Hobbs 1983). Feral pigs also have adversely affected plant communities, especially by trampling and rooting under oak woodland and chaparral canopies (Baber 1982). Pig activities have inhibited regeneration of native trees and shrubs, caused destruction of the litter layer and upper soil horizons, and promoted accelerated erosion on Santa Cruz and Santa Catalina islands (Baber 1982; Peart et al. 1994).

Erosion caused by overgrazing was often severe, and occurred on all the islands where extensive sheep operations took place. On San Miguel Island, overgrazing destabilized sand dunes, resulting in large-scale sand movement and soil erosion and damage to many

Figure 2.3. Severe Erosion on Southwest Santa Cruz Island, Exacerbated by Historical Overgrazing and Significantly Impacting Archaeological Sites (photo by K. Gill).

archaeological sites (Erlandson et al. 2005). The southwest side of Santa Cruz has been hit particularly hard by historical erosion (Figure 2.3), with deep gullying and significant soil loss apparent. While it is unknown how many sites have been lost to erosion over the last century, the number may be significant (Erlandson et al. 2015; Rick et al. 2014a).

## The Marine Environment

### *Ocean Currents and Sea Surface Temperatures around the Islands*

The mixing of cold and warm water currents in the southern California Bight highlights the region as transitional from generally cool and wet to warm and dry. The California Current, part of the North Pacific Gyre, moves cold water south along the western coast of North America. The Davidson Current, also known as the southern California Countercurrent, is a smaller, warm water current that flows northward from Baja California into the Santa Barbara Channel region, where it meets the colder waters of the California Current moving south (Figure 2.4). The mixing of these waters supports a diverse community of marine resources, especially around the islands, where both warmer and cooler waters occur.

The cooler waters of the California Current are particularly productive, largely due to upwelling that facilitates large blooms of phytoplankton, supporting progressively higher trophic levels of marine life. The warmer waters of the Davidson Current also support marine life different in composition from that supported by colder water, resulting in overall increased diversity of marine resources in these transitional areas. As noted by Blanchette et al. (2006:689), on Santa Cruz Island "there is a persistent difference in mean annual sea surface temperature (SST) around the island due to its location at the confluence of opposing

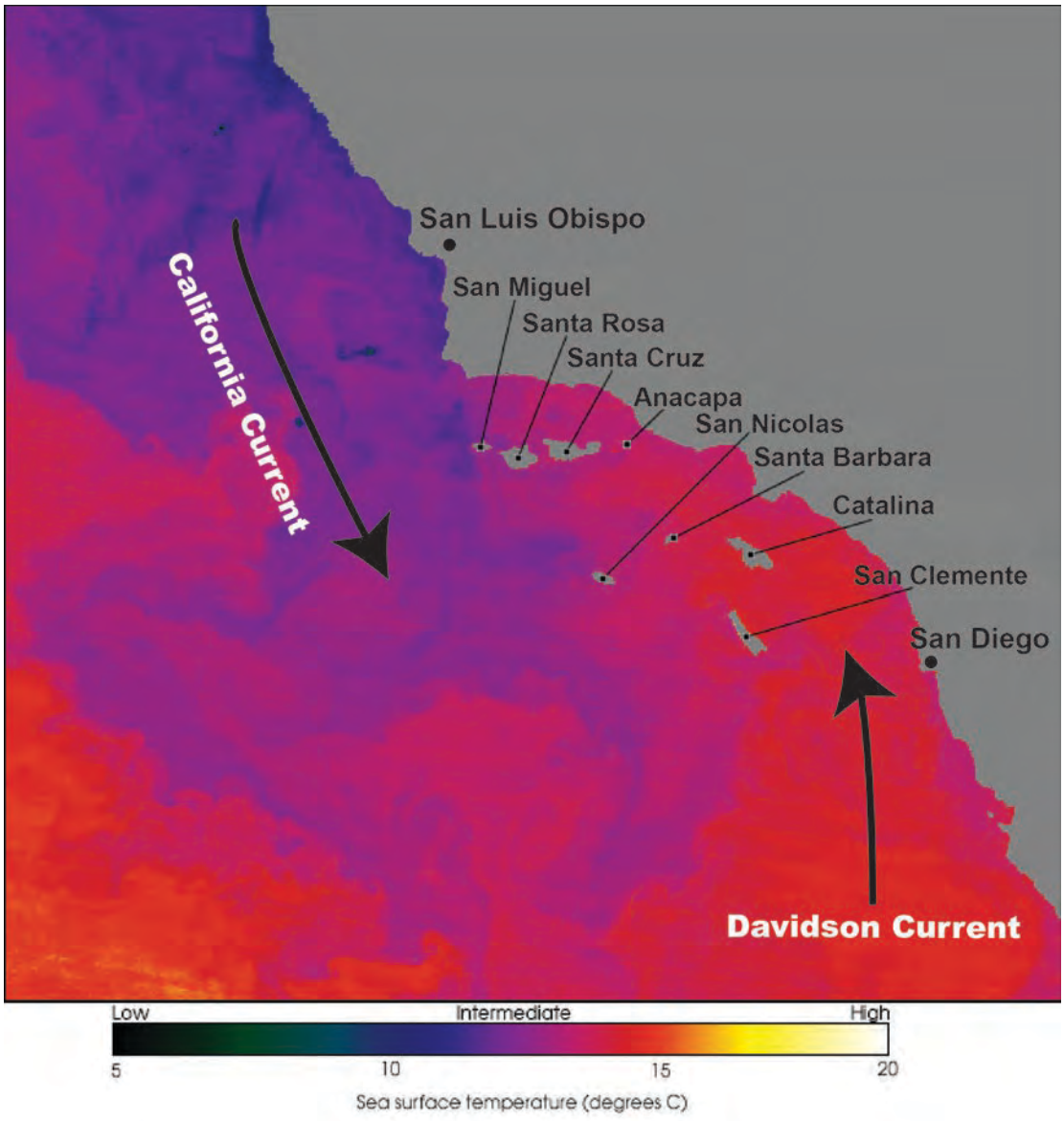


Figure 2.4. Sea Surface Temperatures in the Southern California Bight, showing the Mixing of the California and Davidson Currents. Base Image courtesy NASA Jason XIV Project.

cold and warm ocean current systems." The variability in SST in turn supports variable taxa, a pattern reflected in the archaeological record as well. For example, wavy top (*Megastrea undosa*) is more common in warmer waters and is typically found in higher densities in sites on eastern Santa Cruz, whereas red abalone (*Haliotis rufescens*) prefers cooler waters and is

generally found in progressively higher densities in sites on western Santa Cruz, Santa Rosa and San Miguel Islands (Braje et al. 2009; Glassow 1993; Glassow et al. 2012; Perry and Hoppa 2012).

Although seasonal fluctuations in SST occur regularly, and larger events such as El Niño Southern Oscillations periodically bring warmer waters further north than is typical, long-term SSTs have shifted through time. Geological cores from the Santa Barbara Basin have provided a long sequence of high resolution climatic and sea surface temperature data for the last 160,000 years (Kennett and Kennett 2000; Kennett et al. 2007). Kennett et al. (2007:352) noted:

> Compared with the previous glacial episode, … Holocene SSTs were warm (average of ~12.5 °C). Three distinct cycles are present in the Middle Holocene with warming between 8.2-6.3 and 5.8-3.8 ka, punctuated by a cool interval from 6.3 to 5.8 ka. The coldest SSTs during the Middle Holocene are centered on 6 ka (~12 °C). The warmest Middle Holocene interval occurred between 4.5 and 4 ka (~15 °C)…. SSTs between 5.8 and 5.2 ka were relatively moderate compared to these warm and cold cycles.

It should be stressed that these are generalized reconstructions based on 50-year averages (25 years for the Late Holocene), and that shorter-term fluctuations also occurred.

*Marine Resources and Effects of Sea Level Rise*

The marine environment of the Channel Islands today, while severely impacted by historical sea otter, pinniped, and cetacean hunting, and historical and modern commercial fishing, points to just how diverse, abundant, and resilient marine resources were through time (Braje 2007; Erlandson et al. 2009; Rick et al. 2008). The islands contain vast stretches of rocky shorelines and tidepools that support extensive shellfish beds, as well as sandy beaches used as haul-outs and rookeries for a variety of pinnipeds. Kelp forests, seaweed beds, and other marine plants around the islands support an astounding variety and

abundance of fish, shellfish, otters, and pinnipeds that use the kelp forests to forage and hide from larger predators (Erlandson et al. 2015a). The extensive kelp forests surrounding the islands provide a three-dimensional habitat and remarkable organic enrichment that supports an amazingly productive and diverse marine food web, one that also subsidizes terrestrial productivity on the Channel Islands.

The Santa Barbara mainland coast from Point Conception eastward is currently characterized by a series of rocky points and sandy beaches interspersed with occasional estuarine habitats and streams. During the height of the last glacial maximum (LGM) around 20,000 years ago, however, sea level was approximately 100 m lower than it is today, resulting in a much broader coastal plain than is seen now (Erlandson et al. 2008; Reeder-Myers et al. 2015). As sea levels rose rapidly after the LGM, coastal areas were inundated, creating a series of estuaries that were attractive to early coastal peoples (Erlandson 1985, 1994). Combined with nearshore marine environments, estuarine habitats increase the overall diversity and abundance of marine resources, as they attract a variety of different species of birds, fish, shellfish, and plants. These smaller estuaries were relatively short-lived, however, largely disappearing from the western Santa Barbara coast around 6,000 years ago as sea levels stabilized and they were filled by sediments carried down from streams (Erlandson 1985, 1988; Erlandson et al. 2008). Graham et al. (2003:35-37) noted that

> [a]s sea level rise slows … estuarine embayments fill with sediment and, given an extended high sea sea-level stand, marshes, meandering coastal streams, mud flats and extensive beaches are ultimately formed…. [and that] the composition of the coastal fauna and flora shifted from a diverse assemblage of edible epifaunal invertebrates (mussels, abalone, oysters, etc.) and seaweeds, to an infaunal assemblage that, except for clams, produced much less food that was useful to people.

Several of the larger estuaries, such as the Goleta Slough and Carpinteria Salt Marsh, continue to exist today, even with substantial modifications during modern times.

A pattern of coastal inundation similar to the Santa Barbara mainland coast occurred on the Channel Islands, but the creation of estuaries appears to have been more limited on the islands compared with the mainland. A notable exception was the Abalone Rocks estuary on the east side of Santa Rosa Island that persisted until about 5,000 years ago (Rick et al. 2005a). Smaller and shorter-lived estuaries may have existed on western and southern Santa Cruz Island. The changes that occurred in the nearshore marine environments as sea levels rose undoubtedly reduced the productivity of some resources such as shellfish in certain areas (Erlandson 1988; Graham et al. 2003).

*The Potential Importance of Marine Algae to Island Subsistence*

Kelp forests are very important in the nearshore marine ecosystem and were used extensively by the Island Chumash for hunting, fishing, and shellfishing. The Islanders also may have harvested the kelp itself, as well as a wide variety of other seaweeds (Erlandson et al. 2015a; Landberg 1965:80). Nearly all non-calcareous marine algae are edible and are high in carbohydrates, fiber, and important vitamins and minerals such as iodine, calcium, potassium, and vitamin A (Mouritsen 2013). Many seaweeds were eaten by coastal peoples around the Pacific Rim (Harrington 1948; Lightfoot and Parrish 2009; Newton and Moss 2005), and many genera were also used medicinally.

The diversity of edible marine algae in the channel region is high, particularly given the overlapping geographic ranges of both warm and cold-water species. Table 2.1 presents some of the edible algae that occur in the channel region today, based on Abbott and Hollenberg (1976) (see Erlandson et al. 2015a). Only the largest genera are reported here, except for smaller genera that are important food sources today in Japan and/or Hawaii,

Table 2.1. Some Edible Marine Algae of the Southern California Bight.

| Genus | Common Name | Range | Size |
|---|---|---|---|
| *Agarum* spp. | Seive Kelp | Japan-Alta California | 90 cm |
| *Ahnfeltia* spp. | Landlady's Wig | Bering Sea-Baja California | 30 cm |
| *Alaria* spp. | Dabberlocks* | Alaska-Alta California | 4 m |
| *Analipus* spp. | Bottlebrush | Japan-Alta California | 35 cm |
| *Asparagopsis* spp. | Limu kohu* | S. Channel Islands-Baja; Hawaii | 20 cm |
| *Callophyllis* spp. | Carola* | Br. Columbia-Baja; Peru-Chile | 50 cm |
| *Chondracanthus* spp. | Turkish Towel | Alaska-Mexico | 1 m |
| *Chondria* spp. | | Japan; Alta-Baja California | 20 cm |
| *Codium* spp. | Dead Man's Fingers | Japan; Alaska-Baja California | 35 cm |
| *Costaria* spp. | Five-ribbed Kelp* | Japan-Alta California | 2 m |
| *Cryptonemia* spp. | | Alaska-Chile | 30 cm |
| *Egregia* spp. | Feather Boa Kelp | Alaska-Baja California | 15 m |
| *Eisenia* spp. | Arame* | Japan; Br. Columbia-Baja California | 2 m |
| *Erythrophyllum* spp. | Red Sea Leaf | Alaska-Alta California | 50 cm |
| *Farlowia* spp. | Farlow's Seaweed | Japan; Russia; Alaska-Baja California | 40 cm |
| *Gelidium* spp. | Agar* | Japan; Br. Columbia-Ecuador | 35 cm |
| *Gracilaria* spp. | Ogonori* | Japan; Hawaii; Br. Col.-Costa Rica | 2 m |
| *Grateloupia* spp. | | Japan; Korea; Br. Columbia-Peru | 2 m |
| *Halosaccion* spp. | Dead Man’s Fingers* | Kamchatcka-Alta California | 15 cm |
| *Laminaria* spp. | Kelp, Kombu* | China; Japan; Bering Sea-Baja | 5 m |
| *Lessoniopsis* spp. | Flat Pompom Kelp* | Alaska-Alta California | 2 m |
| *Macrocystis* spp. | Giant Kelp* | Alaska-Baja California; Chile | 50 m |
| *Mazzaella* spp. | Rainbow Kelp | Kapan; Kurils; Alaska-Baja California | 1 m |
| *Monostroma* spp. | Sea Lettuce* | Japan; Alaska-Alta Calif; Chile; Hawaii | 12 cm |
| *Nereocystis* spp. | Bull Kelp* | Alaska-Alta California | 40 m |
| *Odonthalia* spp. | Sea Brush | Bering Sea-Alta California | 40 cm |
| *Oputiella* spp. | Prickly Pear Seaweed | Alaska-Baja California | 30 cm |
| *Palmaria* spp. | Red Kale, Dulse* | Alaska-Mexico | 25 cm |
| *Pleurophycus* spp. | Broad-ribbed Kelp | Alaska-Alta California | 90 cm |
| *Porphyra* spp. | Nori* | Japan; Alaska-Baja California | 90 cm |
| *Prionitis* spp. | | Japan; Alaska-Baja California | 1 m |
| *Rhodomela* spp. | | Bering Sea-Alta California | 20 cm |
| *Sargassum* spp. | Hijiki* | Japan; Alta-Baja California | 2 m |
| *Schizymenia* spp. | | Japan; Alaska-Baja California | 40 cm |
| *Ulva* spp. | Sea Lettuce* | Bering Sea-Chile; Pacific Islands | 1 m |

Notes: Includes only larger taxa, growing to lengths of 5 cm or more. Sizes reported are generally the maximum length of thalli or width of blades. * Major foods cultivated or harvested in the wild today. Compiled from Abbott and Hollenberg (1976).

many of which are also commercially cultivated. Sustainable commercial harvest of giant kelp along the California coast once reached 140,000 tons annually, a testament to the productivity of this type of marine algae (Abbott and Hollenberg 1976:257).

Despite the abundance and diversity of edible seaweeds in the southern California bight, direct archaeological evidence for the use of seaweeds is lacking. The preservation of seaweeds archaeologically is rare, as they are delicate and do not contain the same structural elements that are easily identifiable in terrestrial plants. However, both direct and indirect evidence for the use of seaweeds has been found along the eastern Pacific Rim. Dillehay et al. (2008) reported a variety of seaweeds (including giant kelp) recovered from the 14,000 year old Monte Verde II site in central Chile, in a stratum well preserved by an overlying layer of peat. Such extraordinary preservation is rare, yet provides direct evidence for the use of seaweeds by early peoples in the Americas. Indirect evidence for the use of seaweeds has recently been identified on San Nicolas and San Miguel islands, through careful examination of small limpets found in shell middens that live primarily on kelps (Ainis et al. 2014). As these limpets are too small to be harvested or eaten directly, Ainis et al. argued that they represent riders on seaweeds being brought into archaeological sites. Finding direct macrobotanical and microbotanical evidence for the use of seaweeds on the Channel Islands may prove to be an important avenue for future research exploring whether seaweeds and kelps were important sources of food for the Island Chumash.

## The Terrestrial Environment

### *Modern Island Terrestrial Plant Communities*

The terrestrial environment of each island varies considerably, depending on topography, precipitation, and relative isolation. Modern island vegetation communities are recovering from historic and modern overgrazing, erosion, and the introduction of non-native species. Nonetheless, it is still difficult to accurately define the prehistoric distribution of vegetation communities (Junak et al. 1995). Also notable is the ethnohistorically documented landscape management by the Chumash through burning, which resulted in more productive resource patches and increased the extent of grasslands at the expense of scrub communities (Anderson 2005; Cuthrell et al. 2012; Junak et al. 1995; Timbrook 1993, 2007; Timbrook et al. 1982).

Despite the limitations to interpreting prehistoric vegetation communities based on modern observations, some general trends can be noted. Twelve plant community types described by Philbrick and Haller (1977) occur on the Channel Islands. The most dominant of these include southern coastal dune, coastal bluff, coastal sage scrub, island chaparral, valley/foothill grassland, southern coastal oak woodland, and island woodland. The extent to which each community is represented on the islands varies; the largest islands (Santa Cruz, Santa Rosa, and Santa Catalina) support most of the twelve communities, whereas the smallest islands, Anacapa and Santa Barbara, support only coastal communities (i.e., coastal dune, bluff, and sage scrub) and valley/foothill grasslands (Moody 2000; Philbrick and Haller 1977). While each of these plant communities support various plant food resources, it is important to note that the valley/foothill grassland community type occurs on all eight of the Channel Islands. Food plants available in this community type include a variety of small

seeds and edible geophytes including brodiaea (on all eight islands) and mariposa lily (*Calochortus* spp.; on the larger islands only) (Junak et al. 1995; Wallace 1985).

Although not directly analogous, modern vegetation distributions can provide valuable information about what plant resources were available to prehistoric populations, where different vegetation patches may have been located and how large different vegetation communities were. A variety of plant species occur immediately adjacent to the productive marine environments along the coast, but the most productive areas on Santa Cruz Island occur in more interior settings. Geographically, the western two thirds of Santa Cruz Island is comprised of two mountain ranges running east-west, with linear valleys between them (see Figure 1.1). Volcanic substrates occur along the northern range; the Monterey Shale formation occurs along the isthmus; and several sedimentary, metamorphic, and granitic basement rock formations occur along the southern range (Junak et al. 1995:9).

*Modern Plant Communities on Santa Cruz Island*

Junak et al. (1995:13-27) described sixteen vegetation communities on Santa Cruz Island, including grassland, coastal-sage scrub, island chaparral, island woodland and coastal oak woodland, bishop pine forest, coastal marsh and estuary, and freshwater seeps and springs. A total of 493 native plant species, within 270 different genera, occur on Santa Cruz Island today (see Appendix A). Valley and foothill grasslands are widespread throughout the island and are especially dominant in the western portions of the Central Valley and along the coastal flats east of Forney's Cove. Important food plants in grassland communities include a variety of small seeds, including grasses, cheno-ams (seeds from the Chenopod and Amaranth families), red maids (*Calandrinia* spp.), etc., as well as several species of edible

geophytes, including brodiaea and mariposa lily. Coastal sage scrub communities are found on dry, rocky slopes throughout the island, although they are most dominant on the south side of the island and south-facing slopes in the central and eastern portions of the Central Valley. Island chaparral occurs primarily on the north-facing slopes of the Central Valley and supports a number of economically important species such as manzanita (*Archtostaphylos* spp.), ceanothus (*Ceanothus* spp.), toyon (*Heteromeles* sp.), island scrub oak (*Quercus pacifica*), and wild cherry (*Prunus ilicifolia*). Island woodland and southern coastal oak woodland communities dominate the north-facing slopes and shaded canyons on the north side of the island, and occasionally in the Central Valley. These community types support several species, including toyon, wild cherry, island ironwood (*Lyonothamnus* sp.), and a variety of oak species, including coast live oak (*Quercus agrifolia*), canyon live oak (*Q. chrysolepis*), island oak (*Q. tomentella*), the occasional blue oak (*Q. douglasii*), and the rare California black oak (*Q. kelloggii*). Valley oaks (*Q. lobata*) are also relatively common throughout the island on open slopes (Junak et al. 1995). The ethnohistorically documented trade between the island and mainland populations throughout the Late Period has been suggested as a possible reason for the variety of oaks found on the island, including those typically found in more interior mainland settings such as the valley, blue, and black oaks (Timbrook 1993).

The Bishop pine forest community includes dense stands of Bishop pine (*Pinus muricata*), ironwood, and coast live oak, and it occurs on the north-facing slopes of upper Cañada Christy, on the north side near Pelican Bay, and south of China Harbor. In addition, permanent freshwater seeps and springs occur throughout the island, but are noted as

especially prevalent in canyons on the north side of the island and along coastal bluffs (Junak et al. 1995).

*Precipitation, Fog, and Fresh Water Availability*

The Santa Barbara Channel region, located approximately 34 degrees north latitude, is characterized by a Mediterranean climate with hot, dry summers and cool, wet winters and an average annual rainfall between 8 and 40 inches (National Park Service 2013). Rainfall in these areas is highly variable and highly seasonal, with Santa Cruz Island receiving 79% of its average annual total of 20 inches during the December-March rainy season, and only 4% during the May-September dry season (Fischer et al. 2009). However, the Channel Islands, as with many coastal areas of California, are inundated by coastal fog during the summer months, as cool, moist air over the ocean meets warmer, drier air over land. The fog tends to be densest during the warmest months (e.g., June through August), when the differential between SST and air temperature is greatest. The fog generally flows south down the California coast, pushed by the prevailing northwest winds, and bends around Point Conception. As a result, the fog tends to be denser and lasts longer through the day in the western areas of the channel, particularly compared with the mainland east of the northern islands.

Fog banks are an important source of humidity and precipitation that varies across and within the islands. Due largely to the prevailing northwest winds, the fog around the northern islands is consistently densest on western and north-facing areas, usually becoming less dense around mid-Santa Cruz Island. The greatest amount of fog drip occurs in areas of

higher elevation, between 300-400 m in the interior of Santa Cruz Island, and likely extends to higher elevations along the northern coasts. Fischer and Still (2007:7) noted that:

> [T]he prevailing summertime NW winds encounter sharply rising terrain … leading to orographic cloud formation. … Since higher ridges provide more orographic lifting, they are more likely to receive thicker orographic fogs for longer duration than lower-elevation[s].

Measuring and monitoring fog drip is being conducted in various areas on the islands, notably San Miguel, eastern Santa Rosa in the Torrey pines, and at several points located on a west-east transect through the Bishop pine forest in the interior of Santa Cruz (Baguskas et al. 2014; Fischer 2007; Fischer and Still 2007; Fischer et al. 2009). The rates of fog drip recorded in these areas generally support "increasing fogginess with increasing altitude … and increasing longitude west in the Channel Islands" (Fischer and Still 2007:6). Table 2.2 presents fog drip volume collected at several monitoring stations on the northern Channel Islands during the summer months (Fischer and Still 2007:6, Table 1). This is an important source of freshwater input (along with reduced evapotranspiration) not measured by traditional rainfall/climate monitoring stations.

Table 2.2. Fog Water Volume Collected During the Summer Dry Season[1]

| Location | Long, ° W | Elev (m) | Coll. Surface Area, $m^2$ | Fog Volume, $L/m^2$ | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Jun | Jul | Aug | Sept | Year |
| San Miguel Island | 120.4 | 152 | 0.35-0.43 | 39-48 | 81-99 | 111-136 | 51-62 | 1995 |
| Torrey Pines | 117.3 | 101 | 0.35-0.43 | 0.1 | 0.4 | 0.3 | 0.1 | 1995 |
| Bishop 1 (coastal) | 119.9 | 61 | 0.093 | 2 | 2 | 0.04 | 0 | 2005 |
| Bishop 2 | 119.8 | 147 | 0.093 | 8 | 16 | 3 | 0.4 | 2005 |
| Bishop 7 | 119.8 | 296 | 0.093 | 38 | 66 | 33 | 8 | 2005 |
| Bishop 8 | 119.8 | 200 | 0.093 | 18 | 14 | 2 | 1 | 2005 |
| Bishop 10 | 119.8 | 437 | 0.093 | 17 | 24 | 6 | 5 | 2005 |
| Bishop 11 | 119.8 | 402 | 0.093 | 43 | 11 | 17 | 4 | 2005 |
| Bishop 12 (inland) | 119.8 | 387 | 0.093 | 25 | 8 | 26 | 6 | 2005 |

[1]Adapted from Fisher and Still 2007:6, Table 1

Not surprisingly, the highest volumes of fog water were collected from San Miguel Island, the westernmost of the northern Channel Islands. While the fog water volume collected from the Torrey pines on Santa Rosa Island is substantially less than that collected on San Miguel or any of the sites on Santa Cruz, the Torrey pines are located on the eastern end of the island, which is often subjected to significantly less fog than the western and northern portions of the island. The data from the Bishop pine forest on Santa Cruz Island were generated from monitoring stations located generally in a west-east transect from the coast inland, and at varying elevations. These data show that fog water contributes directly to soil moisture during the driest months of the year, sometimes in substantial volumes, and particularly in areas further west and/or at higher elevations. Lower elevation areas that are typically below the main fog drip zone are subject to cloud shading, which significantly reduces the effects of evapotranspiration in plants and increases overall soil moisture (Fischer et al. 2009). While these data represent only a brief period of monitoring, and fog water volumes were undoubtedly variable through time, they illustrate the potential contribution of fog to overall precipitation on the islands, particularly during the summer months when rainfall is lowest. This may be especially important for the westernmost islands, including San Miguel, Santa Rosa, Santa Cruz, and San Nicolas, and at the higher elevations.

*Cumulative Effects of Overgrazing on the Terrestrial Environment*

The cumulative effects of overgrazing on the terrestrial island ecosystem should not be underemphasized for archaeological interpretation of the terrestrial environment prehistorically. Since the disappearance of the pygmy mammoths from the islands around 13,000 years ago, the native island flora (particularly island endemics) evolved without the

presence of large herbivores that persisted on the mainland. As a result, island plants did not need to invest in the same evolutionarily costly natural defenses their mainland counterparts did in order to deal with herbivores such as deer, gophers, and rabbits (John Knapp, personal communication 2015). The introduction of grazing animals, therefore, may have been significantly more devastating to the island flora than it was elsewhere on the mainland, even given the similarities in native plant genera.

The full extent to which the native flora were affected by overgrazing is not yet well understood, and ecologists are currently attempting to determine how many taxa were extirpated or are now extinct. However, it appears to be the island endemics that are recovering faster than other native taxa since the removal of grazing and feral animals (John Knapp, personal communication 2015). Given the compelling impacts on the native flora during historic times, combined with an outdated native flora checklist for the islands (Junak et al. 2003), it is very difficult (and largely inappropriate) for us as archaeologists to use the modern absence of a particular plant resource on the islands as evidence for island-mainland exchange networks when that resource is identified archaeologically.

Similarly, the cumulative impacts of overgrazing to the island hydrology should not be underemphasized either. The contribution of fog drip to the island hydrology as described above can be significant, but only when that moisture makes it into the ground. Plants play a significant role in collecting moisture from the fog, depositing it directly into the ground and ultimately recharging ground water supplies. The significant reduction in overall vegetation cover during historical overgrazing greatly reduced the efficacy of fog drip, ultimately reducing the overall amount of fresh water in the entire system. As plant communities continue to recover, increasing amounts of moisture from fog drip are recharging the

hydrological system. While archaeologists have tended to view the islands as low in both terrestrial plant and freshwater resources prehistorically, this perception may be far from the truth.

Despite the historical limitations, modern plant communities offer clues to prehistoric diversity and abundance of island plant resources. Modern observations of recovering island flora, combined with ethnohistoric records and paleoethnobotanical data, provide a baseline for testing ideas about prehistoric plant resources on the islands. As additional paleoethnobotanical research continues to generate data about ancient plant use, our understanding of the nature and composition of prehistoric plant communities over space and time will become more refined as well. This type of information will be important for archaeologists, land managers, and restoration ecologists interested in past human-environment interactions on the Channel Islands.

# CHAPTER 3

# ISLAND PLANT SUBSISTENCE, CHUMASH ETHNOBOTANY, AND PREVIOUS PALEOETHNOBOTANICAL RESEARCH

## Assumptions about Terrestrial Plant Subsistence on the Islands

Assumptions about the nature of island terrestrial plant resources, the technologies that were presumably used to process them, and the role of plant foods in the regional exchange network, have all had profound influences on archaeological interpretations. My earlier overview of modern terrestrial plant communities hinted at the diversity and abundance of plant food resources available on the islands, even after years of historical overgrazing practices. As the island flora continue to recover after the removal of grazing animals, we will continue to learn more about the bounty of terrestrial resources the islands had to offer prehistoric peoples.

Prior to the relatively few rigorous paleoethnobotanical analyses of island macrobotanical assemblages (see below), archaeologists relied heavily on indirect evidence and the ethnohistoric record to make inferences about the nature and importance of plant foods on the islands. For example, shifts in settlement patterns, dental caries rates, and frequencies and types of groundstone artifacts collectively imply plant use on the islands. Kennett (2005:226) suggested that plant foods were a relatively important part of the diet on the Northern Channel Islands during the Middle Holocene based the frequency of smaller residential bases located in interior settings (presumably plant collecting locales) with evidence of coastal resources being imported to these sites. After around 3000 cal BP, it appears that people shifted many of their settlement locations from interior settings to coastal

ones, possibly indicating an increase in maritime orientation compared with earlier periods (Perry and Glassow 2015). Walker and Erlandson (1986) suggested that plant use decreased through time from ca. 4000 cal BP on Santa Rosa Island, based on a significant decrease in dental caries seen through time. In addition, Delany-Rivera (2001:177) found that groundstone densities on Santa Cruz Island decreased by 21% from the Middle to the Late Periods, and she suggested that the islanders may have been receiving pre-processed plant foods from the mainland during a time of increased regional exchange. These lines of evidence seem to point towards a decrease in the emphasis of island plant foods through time. However, these ideas have yet to be tested using direct lines of evidence.

Arnold (2001) and Arnold and Martin (2014) suggested that mainland plant foods played an important role in regional exchange networks, based largely on ethnohistoric records and the prevailing assumption that island plant foods were not sufficiently abundant to support growing island populations, particularly during and after the Medieval Climatic Anomaly. These arguments also incorporate paleoethnobotanical data from several Middle/Late Transition and Late Period coastal sites. Arnold (2001) proposed that, given the low densities of acorn nutshell identified in archaeobotanical assemblages from these coastal sites on Santa Cruz Island (Martin and Popper 2001), and high frequencies of acorn nutshell found in a few Late Period mainland sites (Hammett 1991; Hildebrandt 2004), shelled acorns may have been processed on the mainland and transported across the channel in exchange for shell beads. Fauvelle (2013) went on to test this hypothesis using experimental data on *tomol* storage capacities and the transport efficiency of shelled versus whole acorns across the channel, concluding that acorns were probably not an important trade item. Gill and Erlandson (2014:570) ultimately agreed with this conclusion, but argued that the low density

of acorn nutshell seen on the islands is more likely "due to the abundance of other island plant foods, not to mainland acorn processing decisions or *tomol* storage capacities." Arnold and L. Martin (2014) and S. Martin and Popper (2001) both identified remains from plants not known on the Channel Islands today (western sea purslane and California black walnut), arguing that these mainland resources supplemented the local island diet during times of resource stress.

These ideas are intriguing, yet the interpretations of these scant paleoethnobotanical data continue to be based on the underlying assumptions that: 1) island plant food resources were too marginal to support island populations; and, 2) island people needed to trade with the mainland to supplement local plant food resources. These assumptions are based largely on the terrestrial environment observed by researchers during and shortly after the ranching era as well as ethnohistoric information. Archaeologists have made particularly influential inferences about island plant use based on ethnohistorically documented associations between groundstone technology and plant processing from other areas in California. As discussed below, these assumptions must be tested archaeologically.

In this chapter, I discuss the procurement and processing of plant foods on the islands. Given the predominance of digging stick weights found on the islands and their ethnobotanical associations, I highlight the importance of geophytes on the islands and elsewhere. I focus on brodiaea (blue dicks) in particular, as they are phenomenally abundant on the islands, and may be a proxy for other ethnohistorically and prehistorically important island plant foods.

**Plant Food Processing and Procurement on the Islands**

Two main types of milling technology were used in native California: millingstone technology, which uses a metate (or grinding slab) and a mano (held in the hand) to grind materials between the two stones using a back and forth motion, and mortar/pestle technology, which uses a pestle (held in the hand) to pound materials held in a bowl-shaped mortar. Both types of technology were documented ethnographically to process a variety of plant and animal resources (M. Sutton 1993). However, numerous assumptions abound in California archaeology regarding: 1) the reliance on particular plant resources (notably acorns and small seeds); and, 2) the relationship between groundstone technology and the processing of these key plant resources. These assumptions are largely based on Kroeber's observations in central California; manos and metates have typically been associated with grinding small seeds, whereas acorn processing has been associated with mortars and pestles (Basgall 1987; Glassow et al. 1988; Glassow et al. 2007; Heizer 1974; Jones 1996; Kroeber 1925; Moratto 1984, 2002).

These assumptions are problematic, yet have been used to infer plant use at sites where these technology types occur. The assumption that sites containing numerous millingstones is indicative of small seed processing and that the increased use of mortars and pestles is indicative of acorn intensification continues in the literature (Erlandson 1994; Gamble and King 1997; Heizer 1974; Moratto 1984, 2002; but see Glassow 1996b and M. Sutton 1993). As more research is beginning to incorporate special techniques for analyzing groundstone technology (i.e., starch grain, phytolith, and blood/protein residues), we are now able to better document the variability of resources processed with these tools using direct archaeological evidence (Hoppa 2014; M. Sutton 1993). These types of analyses are in their

initial stages in the Channel region, yet will likely influence how we interpret the use of groundstone tools on the islands in the future. For now, it is important to understand past biases regarding the association between groundstone tool types and particular resources, and how this has shaped our current understanding of plant use in the Santa Barbara Channel region.

*Manos, Metates, and the Millingstone Horizon*

Native people throughout California used manos and metates, or millingstones, starting very early in time, around 9,000 years ago up through the historic period. Sites that contain abundant millingstones, few projectile points, and fewer vertebrate remains than during previous periods are particularly abundant in southern California, occurring in both coastal and interior settings (Erlandson 1994; Erlandson and Colten 1991; Fitzgerald and Jones 1999; Kowta 1967; M. Sutton 1993). This pattern, recognized by several early archaeologists, was originally described as the Oak Grove Tradition (Rogers 1929) and eventually dubbed the Millingstone Horizon (Wallace 1955:219).

Millingstone sites have proved particularly difficult to interpret using traditional archaeological methods. Further complicating our understanding of the Millingstone Horizon is the high degree of bioturbation seen in most mainland sites. Nevertheless, the abundance of millingstones recovered from the southern California mainland coast (and elsewhere in California) points to a subsistence regime that was common on the mainland during this early time period. Based largely on Kroeber's (1925) ethnographic observations, millingstone technologies have typically been associated in the archaeological literature with processing small seeds by grinding them into flour. Combined with a low frequency of vertebrate

remains and few chipped stone artifacts, archaeologists have concluded that people during the Millingstone Horizon subsisted largely on small seeds and shellfish, and to a lesser extent large game such as deer (Erlandson 1994; Arnold et al. 2004).

Despite the preponderance of millingstone sites along the California mainland coast, the Millingstone Horizon does not occur on the Channel Islands. Millingstones have been found on the islands, but only in very low numbers, suggesting an island subsistence regime different from the mainland, even early in time. Archaeologists working on the islands have long recognized this pattern, suggesting first that the islands were settled later in time (Olson 1930; Rogers 1929), and later that plant exploitation and processing were not important on the islands, possibly due to high marine productivity, lowered plant resource availability, or a combination of factors (Erlandson 1994; Glassow et al. 2007; Orr 1968; Rick 2007; Rozaire 1965). If millingstones were used primarily for processing small seeds, and there were few small seeds to process on the islands, or small seeds were simply not needed with the abundant marine resources, there would be no use for millingstone technology on the islands. The assumption that the island flora were 'depauperate' helped explain the lack of millingstones at island sites, while the lack of millingstones further strengthened the argument that the island flora were, in fact, depauperate (Arnold 2001; Erlandson 1994; Glassow et al. 2007; Kennett 2005; Rozaire 1965:49). The explicit circularity of this line of reasoning ultimately resulted in a long-standing and broad-scale dismissal of island plant resources, a notion that is directly challenged by archaeobotanical data presented here.

*Bowl Mortars and Pestles*

Mortar and pestle technology differs from milling equipment by using a pounding, rather than grinding motion. This technology appears in the Santa Barbara Channel region around 6,000 years ago, occurring on both the mainland and all eight of the Channel Islands (Glassow 1996; Perry and Glassow 2015). Several different types of mortars have been described ethnographically and identified archaeologically, including large and small stone bowl mortars, wooden bowl mortars, bedrock mortars, and hopper mortars (Hudson and Blackburn 1983). Archaeologically, the most common type of mortar found on both the mainland and the islands is the stone bowl mortar. Several bowl manufacturing sites have been identified on the islands; use of metavolcanic rock on San Clemente, San Nicolas and San Miguel; and sandstone on Santa Rosa, San Miguel, and southwestern Santa Cruz (Conlee 2000; Schneider and Osborne 1996). Stone mortars made of non-local materials have been found at many sites on the islands and mainland, indicating the importance of stone bowl manufacture and trade within regional exchange networks (Conlee 2000; Kennett and Conlee 2002; Wlodarski 1979).

Bedrock mortars have been identified on both the islands and mainland, although they occur less frequently than portable stone mortars. Unlike portable stone mortars, which can be manufactured in one location and transported to another, bedrock mortars are restricted to locations where suitable bedrock outcrops occur. On Santa Cruz Island, volcanic substrates, the best outcrops for bedrock mortars, are located primarily along the northern range, compared with the sandstone and metamorphic substrates that dominate the southern half of the island. Only a handful of bedrock mortar sites have been identified on Santa Cruz Island: A flat stone slab containing five bedrock mortars at the confluence of the three forks of

Smugglers Canyon on the eastern end was lost to flash flooding during the 1997-1998 El Niño storms (Perry 2003:186); three sites that contain a single bedrock mortar each occur within the Central Valley, including one 3.2 km inland from the coast above Cañada Christy (CA-SCRI-574) (Glassow 2014), and two along Centinela (CA-SCRI-813 and -814), and another recently recorded site (CA-SCRI-857) near Black Point Canyon on the west end of the island. The Diablo Valdez site contains five bedrock mortars, discussed in more detail in Chapter 6 (see also Gill 2013, 2014). There are undoubtedly more bedrock mortar features yet to be found on Santa Cruz Island, as many of the most promising areas (i.e., the rugged northern side) have not been systematically surveyed.

Figure 3.1. Hopper Mortar from Santa Rosa Island (CA-SRI-783) (photo by K. Gill).

Other types of mortars are less well represented in the archaeological record, although they probably represent similar processing. Wooden mortars are known from ethnohistoric collections but are rare or absent archaeologically, probably a product of preservation bias. Hopper mortars, typically associated with later time periods, are characterized by a bottomless basket adhered to a stone base with asphaltum. Typically, only the stone with shallow depression surrounded by a ring of asphaltum around the grinding basin is preserved archaeologically (Figure 3.1). Large stone mortars, which can measure over 50 cm in diameter, were described ethnographically as those used for processing large amounts of acorns or other plant foods for feasts. They have been found on the mainland and underwater in the Santa Barbara Channel, but are rarely found on the islands (Hudson and Blackburn 1983:109-110).

*Digging Stick Weights (Doughnut Stones)*

Digging stick weights, also known as doughnut or perforated stones, are stones that have a single hole drilled through the middle. They vary in size, shape, and extent of modification around the exterior margins, ranging from expedient to ornate (E. Sutton 2014). Some doughnut stones have battered margins, suggesting they were also used as hammerstones (Figure 3.2). Although not all perforated stones were necessarily used as digging stick weights, the majority of ethnohistoric accounts suggest they were used in this manner (Hudson and Blackburn 1979).

Abundant ethnographic information exists for the use of digging sticks weighted with doughnut stones like the one shown in Figure 3.2. Hudson and Blackburn (1979:241-243) provide ethnographic information collected by Henshaw in the 1880s and Harrington in the

Figure 3.2. Digging Stick Weight with Battered Margins and an Unidentified (Non-organic) Resin on the Interior, San Miguel Island (photo by K. Gill).

1930s regarding the use of digging sticks, which were sometimes weighted with doughnut stones depending on digging conditions and were used primarily for procuring brodiaea, or *cacomite* (described in more detail in the following section):

> [Henshaw] obtained a clear idea of the use of the digging stick … especially from women who used them. The stick was smooth and round and pointed at one end. The stone whorl was slipped over and run down to about the middle of the stick where it was apparently held in place by the bulging of the stick. Its function was solely to add to the weight. … The root mostly obtained was *ka-ko-mi-ti* as the Spaniards call it or *hu-ku-h* or *ci-ka* in Ventura, *ci-hon* in Santa Barbara. This is onion-shaped and well-known to the Spaniards [Heizer 1955:103].

Harrington collected additional information in the 1930s about digging sticks from various consultants. Both Maria Solares (MS) and Fernando Librado (FL) corroborated Henshaw's information that digging sticks were used specifically for digging *cacomites* (Hudson and Blackburn 1979:241-243):

> *ĭck'umu'*, the digging stick used for cacomite…[JPH/MS]
>
> Both men and women used digging sticks. Men used the heavier ones. Made from ironwood or toyon. [Fernando Librado] never saw a stone sunk into the body of the stick. The old digging sticks were solid, and some had no stone weight; it all depended on what they wanted to dig and when. The women dug cacomites with digging stick. When one dug, they would throw the dirt out. [JPH/FL]

Figure 3.3. Using a Digging Stick Weighted with a Stone, Santa Cruz Island (photo by J. Erlandson).

Hudson and Blackburn suggest that there were two different types of digging sticks, although it appears that three variations may have been employed in different contexts. A digging stick could be large or small, and weighted with a perforated stone or not. The placement of the stone on the stick varied, but was usually placed towards the bottom or affixed towards the top of the stick with asphaltum (Hudson and Blackburn 1979:246; E. Sutton 2014). Figure 3.3 shows how digging for brodiaea is done using a small digging stick weighted with a doughnut stone near the base.

Doughnut stones have been found throughout southern California but are particularly prevalent in island assemblages compared with the adjacent mainland (E. Sutton 2014). Sutton's analysis of doughnut stones from southern California shows that of all 525 specimens housed in museum collections throughout California, 71% come from the northern islands, 16% come from the southern islands, and only 13% come from the mainland. Given the preponderance of digging stick weights on the islands compared with the mainland, geophytes were likely a more important food resource on the islands compared with the adjacent mainland, and possibly elsewhere in California (E. Sutton 2014; see Gill 2013, 2014). Doughnut stones have also been recovered from several Early Period deposits, including cemeteries, suggesting a history of using digging sticks for harvesting geophytes on the islands that may span at least 7500 years (see Orr 1968).

*Food Underfoot: Geophytes*

Geophytes were an important food source around the world, particularly in Mediterranean climatic zones (see Anderson 2005; J. Deacon 1984; H. Deacon 1993; Ertuğ 2000; Gott 1982; Kelly 1995; Klein 1975; Laden and Wrangham 2005; Marean 2010a;

Opperman and Heydenrych 1990; Vincent 1985; Wohlgemuth 2010). Geophytic plants are characterized by an underground storage organ (including tubers, bulbs, corms, and rhizomes), from which the leaves and flowers originate perennially. Most geophytes are well adapted to Mediterranean climates. They experience seasonal dormancy; above-ground parts die back and the underground storage organ conserves nutrients until favorable environmental conditions return (Dafni et al. 1981; Rankiær 1934:65; Rundel 1996; Schlising and Chamberlain 2006; Vaughton and Ramsey 2001). Generally rich in carbohydrates and other nutrients, many geophytes provided foragers and farmers with an energy source that complements diets where sources of whole proteins and fats are regularly available from resources such as shellfish, fish, birds, and sea mammals (see Erlandson 1988).

Ethnographic information for the Santa Barbara Channel region and other areas of California, the Great Basin, and the Columbia Plateau indicate that geophytes generally were harvested in the spring before, during, or after flowering, depending on the particular geophyte targeted (Anderson 1997:153; Anderson and Rowney 1999:233; Prouty 1995:15-19; Timbrook 1993:56, 2007:75). This is especially true of regions where non-corm producing geophytes were particularly important, such as camas, biscuitroot, and yampah. Some of these geophytes, such as biscuitroot and yampah, were available for only a few weeks in early spring, and others, such as camas, were harvested during flowering to avoid accidental collection of the poisonous death camas (*Zigadenus* sp.), whose bulbs look similar to camas but have white rather than blue flowers (Prouty 1995). Spring harvests of geophytes in the Pacific Northwest, northern Great Basin, and Columbia Plateau were important for securing sufficient food reserves to last through the long winter months, and some estimates

of dietary contribution suggest the spring geophyte harvest supplied nearly 50% of the annual caloric intake (Hunn 1990; Prouty 1995:22).

The Brodiaeas

The brodiaea complex (Themidaceae) is described by Fay and Chase (1996:446) as "[p]erennial herbs, with a corm, having a tunic of parallel or reticulate fibers and lacking alliaceous [onion-like] chemistry." A corm is technically an underground stem, resembling a bulb, but with a solid internal structure rather than layers of fleshy scales like an onion. As described previously, the brodiaeas include three closely related genera (*Brodiaea* spp., *Dichelostemma* spp., and *Triteleia* spp.), and four 'satellite genera' (*Androstephium* spp., *Bloomeria* spp., *Muilla* spp., and *Triteleiopsis* spp.) in western North America (Pires and Sytsma 2002:1342). These seven genera are morphologically similar, with overlapping biogeographic ranges, but *Dichelostemma capitatum* has by far the widest distribution, from Oregon to Baja California, including all the islands off the coast of Alta and Baja California except for San Geronimo and Natividad, and from the Pacific Coast east to Utah and New Mexico (Junak et al. 1995:278; Keator 1968; Schlising and Chamberlain 2006). A closely related group of corm-producing geophytes in the family Themidaceae, the *Milla* complex (*Dandya* spp., *Bessera* spp., *Milla* spp., *Petronymphe* sp.), occur in Mexico and include four genera. *Milla* corms are very similar to those of brodiaea, separated largely by biogeographic distribution and corm coat (membraneous vs. fibrous) characteristics (Pires and Sytsma 2002:1353).

The folk term 'Indian potato' commonly refers specifically to brodiaea throughout much of California (Anderson and Rowney 1999; Todt 1997). Other common names for

brodiaea seen in the ethnographic literature include '*cacomite*,' 'wild hyacinth,' and 'grass-nut' (Anderson 1997:19; Timbrook 2007; Todt 1997). The term *cacomite* is often attributed to early Spanish explorers, although the term actually derives from a Nahuatl word (*cacomitl*), defined as "certain roots that have the flavor of chestnuts," indicating the importance of a similar edible geophyte (likely of the *Milla* complex) in Central Mexico (Molina 1571:11).

Among the Chumash, the term *cacomite* was most commonly applied to blue dicks (*D. capitatum*), while other geophytic plants such as the mariposa lily (*Calochortus* spp.) were referred to as "another kind of *cacomite*" (Timbrook 2007:75). The Chumash used the term *shiq'o'n* to describe the plant "as having blue flowers and a root like garlic" (Timbrook 2007:75). While the majority of ethnographic literature suggests that most geophytes, including brodiaea, were harvested during the spring or early summer (Anderson 1997:153; Prouty 1995:15-19; Timbrook 2007:75), two records hint to a second season of harvest for brodiaea (see Gill 2014). In an article translating Karuk stories from the Klamath area, Harrington (1930:131) indicates two seasons of harvest for brodiaea:

> *'Atáytcúkkinatc*, a name given to the Cacomite, *Brodiaea capitata* Benth., when the top is only about 3" above the ground. The entire plant is gathered at this stage early in April and is baked in the ashes wrapped with Blue-bell or other leaves and is eaten by the hungry Indians. After the Cacomites pass this stage they are not molested until they get mature in midsummer, when they are called *tayî·θ*. A swampy place where *tayî·θ* is found is designated at either stage of growth by the special name *'icrávic*.

Harrington's description is consistent with other ethnographic references to a spring harvest, but he noted that *cacomites* are harvested again in mid-summer after they mature, at which point they are given a different name. The assignment of two different names to the same plant in different seasons is intriguing, a practice that may also have occurred elsewhere in California.

The Owens Valley Paiute may also have harvested brodiaea in two separate seasons, using two separate names. Steward (1930:245-247) originally described two cultivated plant foods known as *tüpüsi'* "having a small bulb" and *nahavita* "having a number of bulbs." Confusion over the botanical identification of these two plants was discussed by Lawton et al. (1976), who suggested the terms reference two different plants (*Brodiaea* s.l. and *Cyperus esculentus*). Alternatively, these terms may very well refer to brodiaea harvested in two different seasons. As described in Chapter 7, the reference to *nahavita's* numerous 'bulbs' in the spring may refer to the numerous cormlets produced by parent corms of brodiaea during the late winter/early spring months prior to flowering (Figure 7.8c) (see Anderson and Rowney 1999:236). The cormlets and parent corms are just as numerous in mid-summer/early fall, yet by this time the cormlets have grown in size and can be detached relatively easily from the parent corm through the process of digging, giving the appearance of a single 'bulb' as described by Steward. It is conceivable that both terms *nahavita* and *tüpüsi'* refer to brodiaea harvested in different seasons, similar to the Karuk practice described by Harrington (1930). Archaeobotanical evidence from carbonized brodiaea corms recovered from the Diablo Valdez site suggests that ancient people also harvested them during the fall (Gill 2014; see Chapter 7).

Regardless of the season, the corms were dug using a digging stick as described above (E. Sutton 2014; Timbrook 2007). They could then be eaten raw, but were more commonly taken back to the village or temporary camp to be cooked in a roasting pit. Fernando Librado indicated that *shiq'o'n* was particularly important on the islands, where several families were involved in harvesting and cooking large quantities in large roasting pits that often measured more than a meter across (Anderson 2005:295; Gill 2013; Hudson

Figure 3.4. The 2014 Spring Bloom of Blue Dicks on Western Santa Cruz Island (photo by E. O'Byrne).

and Blackburn 1983:213; Timbrook 2007:75). Librado's reference to the importance of blue dicks on the islands is not surprising, given their phenomenal abundance as evidenced by the spring bloom (Figure 3.4). As described in more detail in the following sections, as well as in Chapter 7, brodiaea corms are commonly found in island archaeobotanical assemblages, sometimes in great abundance (see Gill 2013, 2014).

**Gender Roles in Plant Processing and Procurement on the Islands**

Although the primary focus of my research is to explore the use of plant foods on Santa Cruz Island through time by groups of Island Chumash, a brief note about gender roles

and their archaeological correlates on the islands is warranted, as archaeologists are often tempted to associate plant procurement and processing with women and quick to invoke a sexual division of labor. These associations may indeed be the case in certain areas and/or time periods, but they are based largely on ethnographic literature (Gamble 2008) and should not necessarily be assumed for earlier time periods. Indeed, the ethnohistoric literature of the Santa Barbara Channel indicates digging sticks were used by both men and women for digging *cacomites*, or brodiaea corms (see above, Hudson and Blackburn 1979).

Several archaeological studies have attempted to address prehistoric gender roles using groundstone as a primary correlate for women's activities (Jones 1996; Buonasera 2013; Hollimon 1990). Mortuary analyses use ethnographic data to make inferences about gender-specific burial accompaniments, based on the sex of the burial and associated accompaniments. Hollimon (1990) examined the sexual division of labor and gender roles on the Channel Islands by comparing ethnohistoric information with sexed burials and associated artifacts on Santa Cruz Island. She found that generally "no strong pattern of differentiation existed between the artifacts associated with males and females during any prehistoric period. Males were just as often buried with groundstone tools and basketry impressions as were females" (1990:120-121). Doughnut stones were associated with both male (n=14) and female (n=9) burials, and Hollimon (1990:156) concluded that "it appears that there is little evidence for sexual division of labor based on burial accompaniments during any prehistoric period" on Santa Cruz Island.

A certain degree of sexual division of labor probably did occur, as women generally had slightly higher rates of dental caries in island populations than men (Walker and Erlandson 1986), suggesting they had greater access to cariogenic plant foods (such as

brodiaea). However, Hollimon's mortuary analysis was unable to identify a sexual division of labor based on groundstone artifacts alone, indicating they are not a good proxy for generalizing gender roles on the Channel Islands. Age, on the other hand, may have been a more important factor in the division of labor than gender. E. Sutton (2014:37-38) suggests that children may have played a significant role in plant food procurement on the islands, based in part on the presence of doughnut stones in child burials. She also noted a Chumash oral narrative, *Coyote and the Children* (Blackburn 1975:220-221), that portrays children digging *cacomites* for their families (2014:38). Based on these analyses, and the ethnohistoric information on digging sticks and digging stick weights, it is apparent that men, women and children were involved in the procurement of geophytes, and likely other plant food resources as well.

**Island Plant Resources and Their Use in the Ethnographic and Archaeological Record**

As mentioned briefly in Chapter 2, today there are currently 493 native plant species within 270 genera documented on Santa Cruz Island alone, based on a 2003 plant checklist that has been only sporadically updated (Junak et al. 2003; John Knapp, personal communication 2014). Future botanical surveys will surely identify additional native island taxa as the vegetation recovers from overgrazing. Appendix A presents a list of all native genera that occur on Santa Cruz Island today, with broad categories of ethnobotanical uses identified, including food, medicine and tools (excluding fuel) (Anderson 2005; Junak et al. 1995; Mead 2003; Timbrook 2007). Ethnobotanical information from various areas of California indicates that of the 270 native island genera, 125 were used as food, 88 were used medicinally, and 52 were used to make tools, including structures. Within the food category,

the plant part eaten is indicated, as well as toxicity (see Appendix A, table notes). While pine technically produces seeds, I have classified them as nuts, as they more closely resemble nuts in nutritional composition than small seeds.

The ethnobotanical information from the Chumash area is not as extensive compared with other areas of California, with only 35 of the native island plants reportedly used as food, 60 used medicinally, and 38 used to make tools. The large discrepancy between the Chumash vs. larger California ethnohistoric records, particularly in the plant foods category may be due in large part to the time period most of the information was gathered, and the age of the informants. Harrington collected the majority of ethnobotanical information about plants between 1911 and 1961 (see Timbrook 2007), many years after native lifeways were altered by the Spanish mission system, the Mexican and American periods of assimilation, agriculture, etc. Furthermore, many of Harrington's consultants were elderly, oftentimes only recalling native uses of plants from their childhoods. These factors may account for the large number of medicinal plants recorded compared with food plants, as well as the small number of food plants recorded in the Chumash area compared with California overall. Ethnobotanical information about the islands specifically is particularly scant, with only 17 identified as having an Island Chumash (Cruzeño) name. Intriguingly, Fernando Librado indicated that while blue dicks (brodiaea) were especially important on Santa Cruz Island, no Island Chumash name was recorded (Timbrook 2007).

*Surfgrass as a Substitute – A Proxy for Island Plant Resources*

Although she recognizes the effects of overgrazing and limitations in reconstructing past plant productivity in her seminal paper on the ethnobotany of the Island Chumash,

Timbrook (1993:49-54) pointed out the lack of some ethnohistorically important mainland plants on the islands. She suggested three strategies for islanders dealing with a lack of these particular plant resources that may have had more desirable properties but were either scarce or not available on the islands: 1) do without it; 2) get it from somewhere else; or, 3) find a substitute. This set of options is inherently simple, and was a reasonably sound way to explain differences in the island vs. mainland plant resource material culture, particularly at a time when the sheep had just been removed from the island and feral pigs still roamed (see Chapter 2). However, the sentiment that certain mainland plant resources have more desirable properties than comparable island resources is largely based on mainland ethnohistoric records, and is therefore inherently mainland-centric. Of course, real differences in properties between certain plants exist, but we should not assume that the island "substitute" plant resource was inferior to the mainland correlate.

For example, archaeological evidence indicates that island populations used locally available plants for a variety of purposes, including basketry, roof thatching, woven mats, cordage, rope, nets, fishing line, storage containers, skirts, etc. (Connolly et al. 1995; Cox 1989c; Erlandson et al. 1999; Martin and Popper 2001; Norris 1997; Orr 1968; Raab et al. 2009; Rozaire 1978, 1989; Salls 1989; Thomas 1995; Timbrook 1993, 2007). One of the most common plant materials used in construction of these items among island populations is surf-grass (*Phyllospadix* sp.), a species commonly found in the intertidal and subtidal zones of rocky shorelines surrounding all of the islands (Junak et al. 1995). While surf-grass artifacts are commonly identified at the island sites, they are virtually absent from mainland assemblages, where tule was more commonly used for these purposes. And while the use of surf-grass does appear in the ethnographic record, "[a]rchaeological evidence shows that

[Island] Chumash use of *Phyllospadix* was much more extensive than Harrington's consultants indicated" (Timbrook 2007:140).

Surf-grass is more abundant around the islands than along the mainland coast, given the extensive sandy beaches along the mainland coast, whereas tule appears to be more abundant on the mainland. It is clear from archaeological records that surf-grass was widely used on the islands but may not necessarily have been considered inferior to tule as a resource. It is possible that surf-grass was the preferred material and that the mainlanders were left needing to find a surf-grass substitute (tule), an idea worth exploring further using archaeological and/or experimental data. The mainland-centric view that mainland plant resources (tule) had superior qualities compared with their island counterparts (surf-grass) may have been applied to other plant resources as well (e.g., dogbane vs. milkweed), that may not have as strong an archaeological signature as surf-grass. Regardless, the number and diversity of island native plants that were used prehistorically in California may be larger (and less depauperate) than previously thought. Native uses of additional genera not represented in the California literature can be found in other areas of North America and beyond, but are not included in Appendix A. Therefore, there are likely additional native island genera that could have been used for food, medicine, and/or tool making. Furthermore, the productivity of the these island plant resources, and plant foods in particular, may be significantly higher than their mainland counterparts, given the lack of herbivores and burrowing rodents.

**Previous Paleoethnobotanical Research on the Islands**

The history of paleoethnobotanical research on the Channel Islands began as early as the 1950s, and this field has become increasingly sophisticated over the past 65 years. Standardized methods for the recovery and presentation of paleoethnobotanical data have been refined substantially over the past few decades, including developments in sampling strategies, flotation methods, and quantitative analyses (Hastorf and Popper 1988; Pearsall 2000; VanDerwarker 2010a, 2010b; Wright 2010). While these standardized methods have been employed in more recent paleoethnobotanical investigations on the Channel Islands, earlier researchers (e.g., Eisentraut 1990; Finnerty et al. 1981; McNulty 2000; Meighan 1954, 2000; Orr 1968; Wertman 1959; Williams 1992; Young 2000) often did not report data in a form that can be used for comparative analysis with more recent studies. In addition, several studies analyzed and reported data recovered from special-purpose features (i.e., hearths, storage pits) or ceremonial contexts only (Eisentraut 1990; Finnerty et al. 1981; Klug and Popper 1995; McNulty 2000; Meighan 1954, 2000; Orr 1968; Wertman 1959; Young 2000), rather than from general habitation debris (Klug and Popper 1993, 1997; L. Martin 2010; S. Martin and Popper 1999, 2001; Popper 2003; Reddy and Erlandson 2012; Reddy 2000a, 2000b, 2003; Thakar 2014; Watts et al. 2015; Wohlgemuth 1997). Special purpose features and ceremonial contexts are fascinating and clearly reflect important ideological and/or ritual patterns, but do not represent general subsistence practices.

Due to the various contexts represented and differences in reporting standards, combined with the relatively small amount of paleoethnobotanical research conducted on the islands overall, a quantitative analysis adequately comparing island assemblages is not feasible at this time. Rather, the summary provided here illustrates the potential of

paleoethnobotanical research in refining our understanding of subsistence and settlement among maritime hunter-gatherer-fishers in Channel Island contexts, and it stresses the need for additional research to allow for future inter- and intra-island quantitative comparison. For a full list of archaeobotanical remains identified on the southern islands, see Gill 2013.

*The Southern Islands*

Of the southern Channel Islands, the majority of the paleoethnobotanical research has been conducted on San Clemente Island, with data available from a total of 25 archaeological sites (Cummings 2000; Eisentraut 1990; Klug and Popper 1997; McNulty 2000; Meighan 2000; Reddy 2000a, 2000b, 2003; Young 2000; Wertman 1959; Wohlgemuth 1997). San Nicolas Island has paleoethnobotanical data available from two sites (SNI-168, -351), and a wood charcoal analysis from an additional site (SNI-56) (Klug and Popper 1993, 1995; Cummings 1993a, 1993b, 1993c; Williams 1992). Paleoethnobotanical data are minimal for Catalina Island, with only two studies suggesting the presence of macrobotanical remains (Finnerty et al. 1981; Meighan 1954). No data are currently available from Santa Barbara Island.

While archaeobotanical collections from 25 archaeological sites on San Clemente Island have been subject to analysis, many of the samples came from ceremonial feature contexts, which warrant some discussion. Seed caches have been found in apparent Late/Historic Period ceremonial features at three sites located on the plateau of the island: the Ledge Site (CA-SCLI-126), Old Airfield Site (CA-SCLI-1487), and the Lemon Tank Site (CA-SCLI-1524) (see Figure 1.1). The contents of these features vary, but commonly include abundant olivella shell beads and whole abalone (*Haliotis* spp.) shells. Other items within

features include (in varying amounts) seeds, basketry, mortars, pestles, abalone shell bowls, perforated stones, steatite plaques and bowls, and tubular stone pipes (Madden 2000; Meighan 2000). In addition, dog, island fox, and raptor burials have been associated with several of these features (Salls and Hale 2000; Meighan 2000; Perry 2013). These unique features have been suggested as possible evidence for the ethnographically documented annual Mourning Ceremony (Meighan 2000), and raptor burials at Lemon Tank may be archaeological evidence for the *panes* or bird ceremony (Salls and Hale 2000).

Undoubtedly, the unique context of these features limits comparative analysis with other feature types. Nevertheless, the archaeobotanical remains identified in these features indicate the importance of local plant resources not only for subsistence but for ceremonial purposes as well. Two of the features at the Ledge Site contained small seeds: Feature 1 contained a variety of plant remains including acorn (*Quercus* sp.), wild cherry (*Prunus* sp.), and various small seeds, including domestic wheat (*Triticum* sp.) and red maids (*Calandrinia* spp.). Feature 5 is described as a small pit containing "thousands of seeds, only one species, *Calandrinia*" (McNulty 2000:64). The Old Airfield Site also contained seeds in a feature context consisting of cached morning glory (Convolvulaceae) seeds (Eisentraut 1990:106; McNulty 2000:63; Young 2000). Of particular interest are the seed caches at the Lemon Tank Site, several of which were associated with animal burials. Six seed caches were identified during excavation, consisting exclusively of red maids seeds contained in abalone (*Haliotis* spp.) shells. Curiously, several of these seed caches also contained human teeth (Eisentraut 1990). The number of red maids seeds varied between caches, ranging from 96 in cache #6 to a staggering 273,240 in cache #5 (Eisentraut 1990:100). In addition, acorn

(*Quercus* sp.) and wild cherry (*Prunus* sp.) were noted during excavation, but were not quantified or included in the final analysis (Eisentraut 1990).

While not associated with the special feature contexts described above, Young (2000) reported macrobotanical remains from the Nursery Site (CA-SCLI-1215). It is unclear, however, whether the samples were taken from feature or midden contexts, and both carbonized and uncarbonized remains were included in the final analysis, making comparison with other data sets impossible, as uncarbonized remains are typically modern in age. Interestingly, however, one manzanita berry pit (*Arctostaphylos* spp.), a resource that does not grow on San Clemente Island today, was identified in the analysis (Wallace 1985).

Macrobotanical analyses of samples from general midden contexts have been conducted at several sites on San Clemente Island, providing evidence for general subsistence practices: CA-SCLI-1239, -1249, PL-100 (Reddy 2000a); LVTA-8, -9, LVTA/SE46 (Reddy 2000b); CA-SCLI-1413, -1784, -1788, -1789, -1779 (Reddy 2002); LT-38, -43, -46, -60 (Reddy 2003); BUDS-4, -5, -8, -12, -13, -14, P5-7C, CA-SCLI-1456, LT-22 (Klug and Popper 1997); CA-SCLI-847 (Wohlgemuth 1997); and CA-SCLI-1802, -1803 (Hildebrandt and Jones 1997). Many of these samples, with the exception of those analyzed by Reddy, were small in volume, and only one sample per site was analyzed. Therefore, only general statements regarding patterns in the macrobotanical record can be made at this time. Overall, densities of small seeds are low at all sites, and acorn is present in low densities at LT-43, -46, and -60 (Reddy 2003). Brodiaea corm fragments are also reported from three sites: BUDS-5, CA-SCLI-1456, and -847 (Klug and Popper 1997; Wohlgemuth 1997).

Paleoethnobotanical studies on San Nicolas Island are relatively minimal, and currently include data from only three sites. Williams (1992) conducted a wood charcoal

analysis of a surface collection of 128 charcoal specimens from CA-SNI-56. While the majority (n=114, or 89%) of specimens were identified as coyote brush (*Baccharis* sp.), 3.9% (n=5) were identified as pine (*Pinus* sp.), and 2.3% (n=3) were identified as manzanita (*Arctostaphylos* sp.) (Williams 1992:3). Coyote brush is common on San Nicolas Island; however, pine and manzanita do not occur there naturally (Wallace 1985; Williams 1992). One species of manzanita (*A. catalinae*) exists on Santa Catalina Island, whereas Santa Cruz and Santa Rosa Islands are home to several species. In addition, while these materials may have been obtained from the mainland, the geographically closest sources of pine include the Bishop pine (*P. muricata*) on Santa Cruz Island and the Torrey pine (*P. torreyana*) on Santa Rosa Island. Alternatively, it is possible that these wood resources were obtained as driftwood. Samples from two sites on San Nicolas have been subject to macrobotanical analysis: CA-SNI-168 and -351. Four samples from a darkly stained basin-shaped feature at CA-SNI-168 revealed only carbonized wood and bark remains, suggesting its use as a special-purpose feature (Klug and Popper 1995). Analysis of samples from both feature and midden contexts at CA-SNI-351 indicated poor preservation at the site, with low densities of both wood charcoal and non-wood macrobotanical remains. Overall, small seeds were identified in low densities, and one corm/bulb (cf. brodiaea) was identified in a sample from the midden context at CA-SNI-351 (Klug and Popper 1993).

Paleoethnobotanical research on Santa Catalina Island is nearly non-existent, with only two somewhat vague references. McNulty (2000:62) describes a personal communication with Meighan (1954), indicating that he "recovered burned seeds in a fire hearth, including Catalina Cherry (*Prunus lyonii*) and charred acorns (*Quercus macdonaldi)* from the Empire Landing Site on Catalina Island." The Empire Landing Site has been given

several trinomial designations, including CA-SCAI-31, -36, and -98, which were eventually combined as CA-SCAI-26, and known locally as the Rippers Cove Site (Reinman and Eberhart 1980; South Central Coast Information Center 2011). Unfortunately, additional information regarding archaeobotanical remains obtained from this site appears to be inaccessible at this time. The recovery of archaeobotanical remains at Isthmus Cove (CA-SCAI-39) on Santa Catalina suggests that mainland plant foods were imported during the Mission Period (Finnerty et al. 1981). According to Finnerty et al. (1981:14), "[c]arbonized seeds identified as corn [*Zea mays*] by the UCLA Botany Department were found in association with the Burial 10 complex, and presumably came from the mainland mission farms." The archaeobotanical remains identified at Isthmus Cove corroborates Jonathan Winship's 1807 observation that the native residents had "grain and vegetables" (Bancroft 1886 XIX:84; Strudwick 2013).

*The Northern Islands*

All paleoethnobotanical research on the northern Channel Islands is relatively recent, with data from fourteen sites on Santa Cruz Island, two on Santa Rosa Island, and two on San Miguel Island (Arnold and Martin 2014; Hoppa 2014; Glassow et al. 2008; Gummerman 1992; Martin 2010; Martin and Popper 1999, 2001; Popper 2003; Reddy and Erlandson 2012; Thakar 2014; Watts et al. 2015). No data are currently available from Anacapa Island.

Santa Rosa Island has limited paleoethnobotanical data available from two sites. Orr (1968:200) reported a large amount (approximately 12 quarts) of red maids (*Calandrinia* sp.) seeds excavated from a burial context at Skull Gulch (CA-SRI-2) on Santa Rosa Island, although no additional paleoethnobotanical research has been conducted at this site.

Erlandson et al. (1999:259) reported the recovery of a small amount of carbonized wood (0.38g) and two fragments of highly weathered and unidentifiable carbonized seeds from screened (1/8") material at CA-SRI-6, a 9300 year old site located at the mouth of Arlington canyon, east of Skull Gulch. Flotation was not conducted at the time, yet the recovery of carbonized material from an early Holocene site indicates a high potential for the recovery of macrobotanical remains on Santa Rosa Island.

Reddy and Erlandson (2012) recently reported the recovery of numerous brodiaea corm fragments (totaling 3.71 g) from various strata that span the early to late Holocene at Daisy Cave (CA-SMI-261) on San Miguel Island. Small seeds, including bedstraw (*Galium* sp.) and goosefoot (*Chenopodium* spp.) were also recovered, although in low densities. The nearly ubiquitous presence of brodiaea corm fragments in cultural strata at Daisy Cave indicates its long-term importance as a food source. A site on the western end of San Miguel Island (CA-SMI-522), dated to approximately 10,500 cal BP, also produced paleoethnobotanical remains, including brodiaea corms, an unidentifiable seed fragment, wild cherry (*Prunus* sp.), and gooseberry (*Ribes* spp.) (Watts et al. 2015). These remains were recovered from previously screened (1/8") and sorted samples labeled as wood charcoal. Neither wild cherry nor gooseberry occur on the island today. Both taxa typically occur on shaded slopes, in canyons, and shaded oak woodland and pine forest, with gooseberry occurring in coastal scrub habitats as well (Junak et al. 1995). As these plant community types are not well represented on the western end of San Miguel Island today or in the recent past, these archaeobotanical remains may reflect vegetation communities that were very different 10,000 years ago (Watts et al. 2015). Future paleoethnobotanical work using

standard flotation procedures on San Miguel and Santa Rosa islands will likely be informative.

Of the fourteen sites on Santa Cruz Island from which paleoethnobotanical data are currently available, eight are located almost immediately adjacent to the coast (CA-SCRI-109, -191, -192, -236, -240, -330, -474, -427), while others (CA-SCRI-174, -183, -194, -393, -568, -823) are located in more inland settings. The majority of these sites date to the Middle to Late Holocene, with the notable exception of the Punta Arena site (CA-SCRI-109) that dates to the Early and Middle Holocene (Glassow et al. 2008; Gusick 2012). All of the archaeobotanical data from Santa Cruz Island come from samples processed using flotation to aid in the recovery of macrobotanical remains (Gummerman 1992; Martin and Popper 1999, 2001; Popper 2003). Overall, good preservation of macrobotanical remains was reported for some sites (CA-SCRI-191, -192, -236, -240, -330, -474, -568, -823) while others had apparent poor preservation (e.g., only wood charcoal was recovered from CA-SCRI-393). Several factors affecting preservation and recovery of macrobotanical remains at these sites include the age of the deposit, the depositional context, and the flotation methods employed in the recovery of macrobotanical remains (e.g., varying mesh sizes, mechanical vs. hand flotation techniques). However, differences in site type and function may be significant factors as well. Collections from three sites (CA-SCRI-174, -183, -194) analyzed by Hoppa (2014) appear to contain primarily medicinal rather than food plants, suggesting that subsistence activities may not have been a focus at these sites.

Nevertheless, the archaeobotanical remains are generally well preserved on the islands, and those recovered from Santa Cruz indicate that food, medicinal, and tool plants were important. Table 3.1 provides a list of previously identified plant remains from various

sites on Santa Cruz. Due to variable methods used to report these data in their original form, Table 3.1 serves as a simple presence table of identified taxa. The total number of sites at which each taxon occurs is also shown, out of a total of 13 sites. However, since three of the site collections analyzed by Hoppa (2014) contained primarily medicinal plants, and CA-SCRI-427 contained only wood charcoal and wild cucumber, there are a total of only nine domestic sites with plant food data.

Overall, brodiaea corms were the most ubiquitous, present at all nine domestic sites. Various fruit-bearing taxa were also recovered, with prickly pear cactus occurring at seven sites and manzanita occurring at six. Other fruits, including toyon, laurel sumac, and lemonade berry, occur at two sites (toyon) and one site (sumac, lemonade berry). Non-toxic nuts occur in low frequencies overall, with black walnut (probably imported from the mainland) occurring at two sites. Both pine and ceanothus were present at only one site each. Toxic nuts, which include acorn and wild cherry pits, require processing to leach out tannic and cyanic acids, respectively, prior to consumption. Acorn occurs at a total of seven sites, and wild cherry was found in three sites. Small seeds are present at all sites that yielded plant food remains, with varying frequencies depending on the genus. Small seed taxa with the highest frequencies include saltbush (8), canary grass (8), red maids (6), phacelia (6), goosefoot (5), tarweed (5), and bulrush (5).

Table 3.1. Food Plants (by Genus) Identified by Previous Researchers on SCRI

| | | Coastal Sites | | | | | | | | Inland Sites | | | | | # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CA-SCRI- | | 109[1] | 191[2] | 192[2] | 236[4] | 240[2] | 330[2] | 427[1] | 474[2] | 174[3] | 183[3] | 194[3] | 568[4] | 823[4] | |
| **Geophytes** | | | | | | | | | | | | | | | |
| *Brodiaea* s.l. | Brodiaea | X | X | X | X | X | X | | X | | | | X | X | 9 |
| **Fruits** | | | | | | | | | | | | | | | |
| *Arctostaphylos* | Manzanita | | X | X | | | X | | X | | | | X | X | 6 |
| *Heteromeles* | Toyon | | | | X | | | | | | | | | X | 2 |
| *Malosma* | Laurel Sumac | | | | | | | | | | | X | | | 1 |
| *Opuntia* | Prickly Pear Cactus | | X | X | X | | X | | X | | | | X | X | 7 |
| *Rhus* | Lemonade Berry | | | | | | | | | | | | | X | 1 |
| **Non-Toxic Nuts** | | | | | | | | | | | | | | | |
| *Ceanothus* | California Lilac | | | | X | | | | | | | | | | 1 |
| *Juglans* | Black Walnut | | X | | | | | | | | | | | X | 2 |
| *Pinus* | Pine | | X | | | | | | | | | | | | 1 |
| **Toxic Nuts** | | | | | | | | | | | | | | | |
| *Prunus* | Wild Cherry | | | X | X | | | | | | | | X | | 3 |
| *Quercus* | Acorn | X | | X | X | | X | | X | | | | X | X | 7 |
| **Small Seeds** | | | | | | | | | | | | | | | |
| *Amsinkia* | Fiddleneck | | | | X | | | | | | | | X | X | 3 |
| *Atriplex* | Saltbush | | X | X | X | X | X | | X | | | | X | X | 8 |
| *Artemesia* | CA Sage; Mugwort | | | | X | | | | | | | | | | 1 |
| *Bromus* | Brome Grass | | | | X | | | | | | | | X | X | 3 |
| *Calandrinia* | Red Maids | | X | X | X | | X | | | | | | X | X | 6 |
| *Chenopodium* | Goosefoot | | | | X | | | | X | X | | | X | X | 5 |
| *Clarkia* | Farewell-to-Spring | | | | X | | | | | | | | | | 1 |
| *Claytonia* | Miner's Lettuce | | | | X | | | | | | | | X | X | 3 |
| *Erodium* | Filaree | | | X | | | X | | | | | | | | 2 |
| *Eriogonum* | Buckwheat | | | X | | | | | | | | | | | 1 |
| *Gilia* | Gilia | | | | | | | | | | | | | X | 1 |
| *Hemizonia* | Tarweed | | X | | X | | X | | | | | | X | X | 5 |
| *Hordeum* | Wild Barley | | | | | | X | | | | | | X | X | 3 |
| *Lathyrus* | Pacific Pea | | | | | | | | | | | | | X | 1 |
| *Lepidium* | Peppergrass | | | | X | | | | | | | | | | 1 |
| *Phacelia* | Phacelia | | X | X | X | | X | | X | | | | | X | 6 |
| *Phalaris* | Canary Grass | | X | X | X | X | X | | X | | | | X | X | 8 |
| *Pickeringia* | Chaparral Pea | | | | X | | | | | | | | X | | 2 |
| *Polygonum* | Knotweed | | | | | | | | | X | | | | | 1 |
| *Rosa* | Rose | | | | | | | | | | | | X | X | 2 |
| *Salvia* | Sage | | | X | X | | X | | | | | | | | 3 |
| *Scirpus* | Bulrush | | X | X | X | | X | | | | | | | X | 5 |
| *Sidalcea* | Checker Mallow | | | | X | | | | | | | | X | X | 3 |
| *Sesuvium* | Sea Purslane | | X | X | | | X | | | | | | | | 3 |
| *Trifolium* | Clover | | | | X | | | | | | | | X | X | 3 |
| *Viola* | Johnny Jump Up | | | | | | | | | | | | X | X | 2 |

[1]Martin and Popper 1999; [2]Martin and Popper 2001, L. Martin 2010; [3]Hoppa 2014; [4]Thakar 2014.

Table 3.2. Plant Families and Non-Food Plants Identified by Previous Researchers

| | | Coastal Sites | | | | | | | | Inland Sites | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CA-SCRI- | 109[1] | 191[2] | 192[2] | 236[4] | 240[2] | 330[2] | 427[1] | 474[2] | 174[3] | 183[3] | 194[3] | 568[4] | 823[4] |
| **Plant Families** | | | | | | | | | | | | | | |
| Asteraceae | Sunflower Family | | | | X | | X | | | | | | X | X |
| Brassicacae | Mustard Family | | X | | | | | | | | | | | X |
| Chenopodiacae | Goosefoot Family | | | | | | | | X | | | | | |
| Convolvulaceae | Morning Glory | | | | X | | | | | | | | | X |
| Cyperaceae | Sedge Family | | | | X | | | | | | | | | |
| Fabaceae | Bean Family | | X | X | X | | | | | | | | X | X |
| Laminaceae | Mint Family | | X | X | X | | | | | | | | X | X |
| Malvaceae | Mallow Family | | X | X | X | | X | | X | | | | | |
| Papaveraceae | Poppy Family | | | | X | | | | | | | | X | |
| Poaceae | Grass Family | | X | X | X | X | X | | X | | | | X | X |
| Rosaceae | Rose Family | | | | X | | | | | | | | X | X |
| Solanaceae | Nightshade Family | | | | | X | | | | | | | | X |
| **Non-Food Plants** | | | | | | | | | | | | | | |
| *Achillea* | Yarrow | | | | | | | | | X | | | | |
| *Ambrosia* | Beach Bur | | | | X | | | | | | | | | |
| *Chlorogalum* | Soap Plant | | | | X | | | | | | | | | X |
| *Galium* | Bedstraw | | | | X | | | | | | | | X | X |
| *Geranium* | Carolina Geranium | | | | X | | | | | | | | | |
| *Hypericum* | Tinker's Penny | | | | | | | | | X | | | | |
| *Lavatera* | Tree Mallow | | | X | | | | | | | | | | |
| *Lotus* | Deerweed | | | | | | | | | | | | X | X |
| *Lupinus* | Lupine | | | | X | | | | | | | | X | X |
| *Malacothamnus* | Bush Mallow | | | X | | | X | | X | | | | | |
| *Marah* | Wild Cucumber | X | X | X | X | X | X | X | X | | | | X | X |
| *Nicotiana* | Tobacco | | | | X | | | | | | X | | X | X |
| *Plantago* | Plantain | | | X | X | | | | | | | | X | X |
| *Silene* | Indian Pink | | | | | | | | | | X | | X | |
| *Sisryncium* | Blue Eyed Grass | | | | | | | | | | | | X | X |
| *Verbena* | Vebena; Vervain | | | | X | | | | | | | | | |
| Salicaceae | Willow Family | | | | | | | | | | | | | X |

[1]Martin and Popper 1999; [2]Martin and Popper 2001, L. Martin 2010; [3]Hoppa 2014; [4]Thakar 2015.

Table 3.2 presents a summary of the presence of plant remains identified to family by previous researchers, as well as non-food plant remains. Some of these plant families contain largely edible genera (e.g., mustard, goosefoot, bean, rose, and grass families), although some genera do not, and some genera within a particular family can vary significantly in

morphology (e.g., wild cherry pits vs. rose hips). As a result, plant families represented on Santa Cruz are treated separately from the list of food plants. Non-food plants include a variety of known medicinal plants, such as yarrow, tobacco, and plantain, while some other plants have no known ethnobotanical use (e.g., ambrosia, tree mallow). Wild cucumber occurs at a total of ten sites. It was used for a variety of purposes, including as a pigment binder or as a treatment for baldness, but is poisonous if consumed (S. Martin 2009; Timbrook 2007). Its prevalence in archaeological sites on the islands and elsewhere in California is discussed in more detail in Chapter 7, where I suggest that it may have been used as kindling on the islands.

**Reconsidering Plant Food Rankings on Santa Cruz Island**

Ranking plant foods in terms of caloric return rates is a useful tool for evaluating optimal foraging behavior and changes in diet breadth (see Chapter 1). Wohlgemuth (2010) ranks California plant categories as follows: 1) Geophytes; 2) Non-Toxic Nuts; 3) Toxic Nuts; 4) Small Seeds; and, 5) Aquatic Rhizomes/Roots. These return rates also take into account procurement and processing costs, which is especially important when considering plant foods that require processing to leach out toxins. Using return rate data from the Great Basin or Columbia Plateau for plant foods may be appropriate for some areas of California, but are probably less appropriate on the islands.

Given the lack of competition for plant foods from herbivores (e.g., gophers, deer, and rabbits), island plant foods were more abundant than their mainland counterparts, resulting in higher return rates overall. Herbivores differentially affect different plant food categories, however. Geophytes are extraordinarily abundant on the islands without gophers,

oaks have higher regeneration rates without deer (Manuwal and Sweitzer 2010), and grasses, greens and wildflowers are more abundant and diverse without rabbits (Courchamp et al. 2003). Alternatively, deer may have less of an effect on the productivity of plants like manzanita or black sage (John Knapp, personal communication 2015). While ranking based on return rate data provides a reasonable starting point, I suggest that return rates alone may not be the best way to rank plant foods on the islands, given the abundant complete proteins and fats accessible in marine resources. These rich marine resources would have been complementary to the plant foods (and vice versa), and the high caloric yields in marine resources probably affected decisions about the types of plant foods targeted on the islands. These decisions would likely be different in other areas of California, where certain plant foods, such as acorns, may have been targeted for both their fat as well as carbohydrate content, given that fat was more difficult to come by.

With complete proteins and fat provided largely by marine resources in the Island Chumash diet, I suggest that the carbohydrate content in plant foods may be more important than overall caloric return rates. Seasonal availability (and storability) of these plant foods, as well as processing costs, are also taken into account. Table 3.3 presents a suggested revised ranking of island plant food categories, including a sample of genera within each category that have been analyzed for proximal nutritional content (protein, fat, and carbohydrate), based on Gilliland 1985, except where noted. A range of values are provided for some genera, typically representing the range of various species analyzed.

While comparatively few island taxa that are known food plants have been subjected to proximal nutritional analysis, several key genera that have been analyzed are useful for reconsidering the ranking of native island plant foods.

Table 3.3. Suggested Ranking of Island Plant Food Categories Based on Carbohydrate Content, Seasonal Availability, and Processing Costs.

| | | | % | | |
|---|---|---|---|---|---|
| **Rank** | **Genus** | **Name** | **Protein** | **Fat** | **Carbs** |
| **1** | **Geophytes** | | | | |
| | *Brodiaea* | brodiaea | 0.6-1.77 | 0.35-1.43 | 30.01-36.56 |
| | *Calochortus* | m. lily | 1.05-2.72 | 0.34-3.76 | 18.83-23.04 |
| | *Allium* | onion | 0.9 | 1.3 | 12.86 |
| **2** | **Kelps and Seaweeds** | | | | |
| | *Nereocystis,* dried | bull kelp | 3 | 5.7 | 57.4 |
| | *Porphyra,* dried | seaweed | 18.6 | 4 | 40.9 |
| **3** | **Fruits, Berries, and Pits** | | | | |
| | *Arctostaphylos* | manzanita | 1.43-1.49 | 2.85-7.55 | 78.56-86.16 |
| | *Prunus*, dried pulp | cherry | 2.67 | 3.22 | 77.8 |
| | *Opuntia*[2] | cactus fruit | 13.1 | 9.9 | 66.3 |
| | *Rosa* | rose | 2.67 | 3.14 | 33.25 |
| | *Heteromeles* | toyon | 2.92 | 2.64 | 27.48 |
| | *Ribes* | gooseberry | 1.87 | 2.69 | 22.9 |
| | *Rhus* | l. berry | 1.86-2.76 | 3.58-4.22 | 11.62-16.99 |
| | *Vaccinium* | huckleberry | 1.65 | 0.25 | 17.15 |
| | *Sambucus* | elderberry | 3.46 | 1.43 | 14.9 |
| | *Rubus* | blackberry | 0.4 | 0.1 | 14.1 |
| **4** | **Small Seeds** | | | | |
| | *Poa*[3] | bluegrass | 10.9 | 0.4 | 73.5 |
| | *Salvia* | sage | 7.9-21.6 | 9.45-20.22 | 44.73-69.44 |
| | *Atriplex*[3] | saltbush | 7.7 | 0.0 | 69.3 |
| | *Chenopodium*[1] | goosefoot | 13.9-15.5 | 4.7-6.9 | 68.8-75.8 |
| | *Rumex* | dock | 8.96 | 2.08 | 61.74 |
| | *Lepidium* | peppergrass | 16.44 | 2.64 | 32.86 |
| | *Brassica* | mustard | 14.41-18.46 | 17.02-18.7 | 21.05-25.92 |
| **5** | **Leaves, Stems, Stalks, Flowers** | | | | |
| | *Clinopodium*, leaves | yerba buena | 0.9 | -- | 31.05 |
| | *Rumex*, stem | dock | 1.6 | 0.61 | 8.95 |
| | *Typha*, dry flowers | cattail | 8.94 | 1.41 | 74.85 |
| **6** | **Non-Toxic Nuts** | | | | |
| | *Pinus pinea*[4] | stone pine | 31.1 | 47.4 | 11.6 |
| | *Pinus sabiniana*[4] | gray pine | 25.0 | 49.4 | 17.5 |
| **7** | **Toxic Nuts** | | | | |
| | *Prunus*, seed | cherry | 5.25 | 3.65 | 70.82 |
| | *Quercus*, raw | acorn | 2.4-4.55 | 3.86-21.8 | 30.3-44.14 |
| | *Q. kelloggii*, leached cooked | | 2.25 | 17.8 | 25.15 |
| **8** | **Aquatic Roots/Rhizomes** | | | | |
| | *Typha* | cattail | 0.45-0.71 | 0.28-0.38 | 3.25-11.63 |

Notes: Data complied from Gilliland 1985, except: [1]Repo-Carrasco-Valencia and Serna 2011; [2]Green 1936; [3]Simms 1987; [4]Farris 1993.

1. Geophytes. As with the ranking scheme based on caloric return rates, geophytes are ranked highest when considering carbohydrate content as well. The values presented in Table 3.3 were based on analysis of raw brodiaea corms, which have a high moisture content (~65%). The actual carbohydrate value of cooked corms may be much higher. Nevertheless, raw brodiaea corms contain upwards of 36% carbohydrates. Combined with their phenomenal abundance on the islands, their low processing costs, and availability nearly year-round (Gill 2014; see Chapter 7), I suggest that geophytes, and brodiaea corms in particular, remain the highest ranked island plant food.

2. Kelps and Seaweeds. Although kelps and seaweeds are not terrestrial plants and are not typically well represented in archaeobotanical assemblages, I have included them here as an island plant food. Kelps and seaweeds are important food sources in many coastal areas, including along the eastern Pacific Rim, and a variety of edible genera exist around the islands today (see Chapter 2). Only limited ethnobotanical information on the use of seaweeds was obtained from the Chumash, although it is reasonable to speculate that they were important to the Island Chumash. The ethnohistorically recorded seaweed dance, or *Shutiwiyish,* hints at the importance of seaweeds among the Chumash, and the Island Chumash in particular. Fernando Librado described to Harrington the seaweed dance, which was performed during big fiestas (e.g., San Miguel Day fiesta in Ventura) or for private parties (Hudson et al. 1981:72-73):

> The seaweed dance was performed by two men, a man and a woman, or two women. Sometimes there was only one dancer, either a man or a woman. The dancers were dressed in a *tsu*h, corona, feather skirt, and had plumeros in their hands. They painted their faces with dots of black and white upon a background of red which covered the entire face…The dancers would enter from the south and dance at various fireplaces. Those who danced would imitate the movement of the seaweed, any kind of seaweed. It was a Cruzeño [Island Chumash] dance, though the songs were in half Cruzeño and half Barbareño Chumash.

Fernando Librado told Harrington that there were between five and six songs that accompanied the seaweed dance, although he could not remember them all. One song, *kiwawimina*, clearly references Santa Rosa Island (*Wi'ma*), further indicating the importance of seaweeds on the islands (Hudson et al. 1981:74):

> He begins to walk. / Where does he come from? / He begins to walk. / He comes from the south. / Let us turn our faces toward the island of *Wi'ma*. / They think he came from there. / This vagabond, where will he come from? / He will come from the south. / He will come from the north. / The vagabond and I turn our faces toward the island of *Wi'ma*. / Perhaps he came from there.

The proximal analysis of bull kelp and seaweed presented in Table 3.3 suggest that dried seaweed is high in carbohydrates (41-57%) relative to protein or fat. These two genera occur in the channel today, in addition to a variety of other kelp and seaweeds. Seasonal availability of kelps and seaweeds depends on the genus and whether it is annual or perennial. Bull kelp (*Nereocystis luetkeana*) is an annual plant, with their holdfasts generally pulled from their substrate during winter storms. However, giant kelp (*Macrocystis* spp.) is perennial, and usually lives for several years. Given the diversity of kelps and seaweeds around the islands, these resources would likely have been available the majority of the year. Despite the higher value of carbohydrates in kelps and seaweeds compared with geophytes, I chose to rank them second. Kelps and seaweeds are abundant and available nearshore, but kelps generally require the use of boats to collect in large amounts, except when washed ashore after large storms. After these storm events, kelps and seaweeds can be found in large amounts on the beaches and would have been easy to collect and dry for future use by island people. Comparing dried seaweed to raw geophytes likely inflates the overall value of carbohydrates in kelps and seaweeds. Nevertheless, kelps and seaweeds would have been a

relatively easily procurable resource that is available the majority of the year, and were likely an important source of food.

3. Fruits, Berries, and Non-Toxic Pits. Fruits and berries are only available seasonally, typically in the summer except for toyon, which is available in the winter. Overall, their carbohydrate content can be high, in addition to providing a variety of vitamins and minerals. Manzanita berry pits contain a very high proportion of carbohydrates (79-86%) and were often eaten raw, ground into a pinole. These berry pits may have been a significant source of carbohydrates during the summer or may have been stored for use during the winter. Although the pit of wild cherry is toxic (and included in toxic nuts), the fruit was also sometimes eaten, either fresh or dried (Timbrook 2007:154), with the dried pulp containing close to 78% carbohydrate. Other fruits, including rose hips, toyon, and gooseberry contain between 33%, 28%, and 23%, carbohydrates respectively, with other fresh fruits containing slightly less, generally no more than 14% carbohydrate. Carbohydrate values for dried fruits and berries are significantly higher than fresh ones, due to their lower moisture content. Regardless, fruits, berries and non-toxic pits may have been seasonally abundant, providing carbohydrates and other vitamins and minerals with minimal processing costs. I also suggest that prickly pear fruit be included in this category.

4. Small Seeds. I suggest that small seeds are ranked fourth, based on their carbohydrate content, seasonal availability, and storability. Small seeds can be harvested in large quantities (Anderson 2005), have minimal processing costs, and can be stored easily. Processing costs for small seeds are slightly higher than for berries and fruits such as manzanita and prickly pear, and both procurement and processing costs are higher than for geophytes. However, small seeds do have relatively high amounts of carbohydrates, with

grasses, cheno-ams and sages containing ~70% carbohydrates. Some small seeds are also relatively high in protein and fat.

5. Leaves, Stems, Stalks, and Flowers. I have included a category for leafy greens in this ranking scheme, as greens were likely an important source of vitamins and minerals, as well as carbohydrates in some cases. Yerba Buena (*Clinopodium douglasii*) leaves, for instance, contain more carbohydrates (31%) than might be expected for leafy greens. Other greens may also contain high proportions of carbohydrates, and additional nutritional analysis of these plant types would be useful. Until additional analyses are complete, I suggest that this category also include prickly pear pads, as they may be high in carbohydrates and other nutrients. As with the kelps and seaweeds, however, leaves, stems, stalks, and flowers do not preserve well in archaeobotanical assemblages and their archaeological signature may be difficult to find.

6. Non-Toxic Nuts. The only non-toxic nut that is native to Santa Cruz Island is the small-seeded Bishop pine. Table 3.3 presents proximate analysis values for two species of pine, including the large seeded gray pine and smaller seeded Italian stone pine. While gray pine seeds are large and probably not directly comparable to Bishop pine, the seeds of Italian stone pine are closer in size and may be more comparable. Values range widely for various species of pine, however, with generally high proportions of fat compared with protein or carbohydrates (mean ± s.d.): protein – 16.1±9.7; fat – 37.8±19.9; carbohydrates – 29.7±19.4 (Gilliland 1985). Nevertheless, I suggest they be categorized as a non-toxic nut, ranked just above toxic-nuts. Although California black walnut does not occur on Santa Cruz Island today, it has been found in a few archaeobotanical assemblages from the island. It has been suggested as a probable import from the mainland, which would increase its processing costs

to transport across the Santa Barbara Channel. Still, California black walnut is relatively high in fat and protein, compared with carbohydrates: protein – 18.77±2.68; fat – 53.4±0.57; carbohydrates – 8.48±1.49.

7. Toxic Nuts and Pits. Toxic nuts and pits include acorns and wild cherry pits, both of which must be leached after pounding into flour to remove the tannic and cyanic acids, respectively. The leaching process is lengthy, but it is clear from ethnohistoric records that wild cherry pits and acorns were eaten by the Chumash (Timbrook 2007). Wild cherry pits contain high proportions of carbohydrates in their raw form (~71%), with carbohydrates in raw acorn ranging from 30-44%. However, as Gilliland (1985) pointed out, it appears as though the leaching process removes some of the fat and carbohydrates. Proximal nutrition of raw acorns, compared with leached and cooked acorns of California black oak (*Q. kelloggii*) (Gilliland 1985) suggests a carbohydrate value lower than for raw brodiaea corms. Acorns are higher in fat, even after leaching, which may have been a significant factor in their importance in other areas in California.

8. Aquatic Roots/Rhizomes. As with the caloric return rate ranking, I suggest that aquatic roots and rhizomes rank last in terms of carbohydrates as well. Cattail is the only aquatic rhizome for which Gilliland (1985) presents data, but it is relatively low in carbohydrates (~12%) compared with all other plant categories. Processing costs for cattail rhizomes are relatively high, as starches need to be separated from the fibrous rhizome by pounding. The comparatively low carbohydrate content combined with higher processing costs of rhizomes suggest this resource should be ranked lower than other plant foods.

*Island Plant Resources*

The plant resources available to prehistoric island inhabitants were less depauperate than previously assumed. Rather than focusing on floristic comparisons with the mainland and what is "missing" from the islands, we as archaeologists and paleoethnobotanists must contextualize island plant resources from an island-centric viewpoint to effectively evaluate how Islanders interacted with their terrestrial environment. Only then can we draw meaningful conclusions about the abundance and diversity of the island plant resource base, human responses to environmental stressors (e.g., drought) in terrestrial subsistence economies, and the role of plants in regional exchange networks. The suggested re-ranking of plant foods for Santa Cruz Island based on carbohydrate content will be re-assessed using the paleoethnobotanical data collected and analyzed as part of this research, and re-evaluated based on those data in Chapter 7.

# CHAPTER 4

# FIELD, LABORATORY, AND QUANTITATIVE ANALYTIC METHODS

My project uses paleoethnobotanical and other archaeological data to better understand how the Island Chumash used and interacted with plants on the islands. In order to address these research questions, I identified two new interior sites with bedrock mortars in addition to the previously recorded Diablo Valdez site, systematically collected surface artifacts from both Diablo Valdez and Brodiaea Ridge, and excavated samples from these three interior sites. Analysis of the resulting collections focuses primarily on the plant remains, with cursory analyses of other constituents including artifacts, domestic features, and faunal remains.

## Field Methods

### *Survey Methods*

I chose the Diablo Valdez site (SCRI-619/620) as the primary focus of my research because it was one of the few recorded bedrock mortar sites on Santa Cruz Island at the time. Initially recorded by M. Glassow in 1997 as part of an undergraduate field methods class taught through UC Santa Barbara, Diablo Valdez was recorded as four separate sites (CA-SCRI-618, -619, -620, and -621). Intensive pedestrian survey methods were used by the 1997 field class targeting a set of ridges descending from the northern ridge line toward the island's north coast. The field class did not survey far beyond the locality where Diablo Valdez was recorded due to time limitations. These four sites are located in spatially distinct areas scattered around a prominent rock outcrop approximately 1 km northwest of Diablo

Peak. For the purposes of this project, I chose to combine these four sites into one large complex containing four distinct loci. The justification for this decision lies in the fact that all of these loci apparently used the same bedrock outcrop landform. Upon closer examination, archaeological materials (artifacts and shellfish remains) also occur throughout the area, with no clear break between loci. There does appear to be a break in archaeological materials on top of the outcrop, between loci 1 and 3, although caliche deposits are apparent throughout, and archaeological materials occur on the slope west of this area. It is possible that heavy erosion (an effect of overgrazing) occurred in this area and washed shallow site deposits off the exposed bedrock. The loci themselves contain significantly higher densities of archaeological materials than in intermediate areas, however, and reflect concentrations of human occupation.

The presence of bedrock mortars at the Diablo Valdez rock outcrop is rare for Santa Cruz Island and the Channel Islands overall, and the presence of five mortars here is unique (see Chapter 6). Combined with the non-coastal location and extensive midden, house pits, and surface artifacts (including bowl mortar fragments), it was an excellent candidate for studying the use of plants at island sites. I also conducted several small-scale pedestrian surveys between 2009 and 2013 in the general vicinity of the Diablo Valdez site, in an attempt to identify similar sites in terms of features (bedrock mortars, house pits) and overall extent of midden at nearby rock outcrops. Archaeological sites were identified along the same ridge as Diablo Valdez, northward down to the coast, as well as around the numerous bedrock outcrops on the ridge east of Diablo Valdez. None of these sites appear to match Diablo Valdez in size or surface artifact density, and no additional bedrock mortars were found. It appears that there are no other sites as large as Diablo Valdez in the immediate

vicinity, although it is likely that similar sites occur along the northern side of the island, probably in similar contexts at upland bedrock outcrops. Future survey work on the northwestern side of Santa Cruz is important for understanding the larger context of the Diablo Valdez site, regardless of the difficulties involved in traversing this rugged landscape.

The Sunburst Site (SCRI-813) and Brodiaea Ridge Site (SCRI-814), each of which contains a single bedrock mortar, were identified and recorded in 2008, during a California Polytechnic State University, San Luis Obispo field class taught by Dr. Terry Jones and myself, along with two staff volunteers, Elise Wheeler (California State Parks) and Dustin McKenzie (Cabrillo College). The objective of the field class was to teach undergraduate students archaeological survey methods while introducing them to the archaeology of the Channel Islands. The field class surveyed interior areas of the western portion of the Central Valley between Portezuela and Centinela in an effort to identify additional bedrock mortar sites. These areas offered the highest probability of encountering bedrock mortars, given the presence of volcanic rock outcrops along the northern range, while avoiding the considerable time needed to travel to the northern side of the northern range. The Sunburst and Brodiaea Ridge sites were identified during these surveys: Sunburst was identified and recorded by my crew just south of the parking area for the Diablo Trail; Brodiaea Ridge was identified and recorded by Dusty McKenzie's crew at the end of the ridge where the new cell tower site was built near Centinela in 2010 (see Chapter 5). No other bedrock mortar sites were identified in the course of this survey, but the survey areas assigned to each crew were not completed, and it is possible additional bedrock mortar sites occur in this area.

*Surface Collection Methods*

When I visited the Diablo Valdez site with the staff and students of a 2007 joint California State University Northridge and Pomona College field school, numerous artifacts were noted on the surface. These artifacts included many portable stone mortar fragments, projectile points, hammerstones, large reamers/peckers, beads, and two doughnut stone fragments (see Chapter 6). Looting on the islands is an ongoing problem, particularly by recreational visitors who are able to access the more remote areas of the island by boat, oftentimes coming ashore. Therefore, artifacts on the surface at Diablo Valdez were documented, mapped, collected, and curated as part of my dissertation research. Surface collection also took place at Brodiaea Ridge, although the artifact density on the surface was much lower than at Diablo Valdez, and only one projectile point was collected (Chapter 5).

*Field Excavation Methods*

Several stages of field investigations were conducted as part of this project. Once the three sites were recorded/revisited, it was necessary to conduct exploratory testing with column samples to determine each site's depth, composition, general stratification, etc. Augers were not immediately employed, as small exploratory column samples (ECS) excavated by hand were more useful in assessments of site stratification and composition. At Diablo Valdez, it became apparent while excavating the exploratory column samples that the site depth extended well beyond the reach of hand excavation in the small 20 x 20 cm units at loci 2 and 3. Consequently, a 4" bucket auger was employed to explore each locus past 80 cm below surface. The auger at locus 3 was successful in reaching the basal deposits,

whereas an obstruction was encountered with the auger at locus 2 at around 120 cm below surface.

I collected five exploratory column samples (ECS) from three loci at the Diablo Valdez site in 2007, and one column sample each from Sunburst and Brodiaea Ridge in 2010 (see Figures 5.2, 5.10, and 6.1). Each ECS was 20 x 20 cm wide and excavated in 10 cm arbitrary levels. I chose the placement of each ECS in dense areas with promise of some depth at each locus, as close as possible to bedrock mortar features, but away from obvious surface features such as house depressions.

Three of the five ECS units excavated at Diablo Valdez were placed within locus 1, located at the northern extent of the bedrock outcrop, adjacent to the two northernmost bedrock mortars. ECS-1, near the center of locus 1, was excavated first, but we encountered the scapula and humerus of an intact human burial at approximately 30 cm below surface. Work halted immediately, all excavated material was returned to the unit, and two alternative ECS locations were placed at the eastern and western boundaries of the locus. ECS-2, placed as close to the bedrock mortars as possible, extended to only 15 cm below surface where bedrock was encountered. The deposit consisted of dark, silty soil and moderately dense shellfish remains underlain by bedrock. ECS-3 was placed near the westernmost extent of the locus to assess the depth and composition of the deposits at locus 1. ECS-3 extended to 33 cm below surface to bedrock, and it encountered a higher density of shellfish than at ECS-2.

ECS-4 was placed within locus 2, on the southern extent of the bedrock outcrop. Locus 2 is large, situated along the ridge in the saddle between the rock outcrop and the slope rising up to the island's main east-west trending northern ridge. Four shallow house depressions are on the leeward (eastern) side of the deposit, which is relatively flat along the

ridge top. While the house depression features are interesting, my primary research focus was on general midden deposits rather than house features, which are typically better investigated with larger excavation units. Therefore I chose to place ECS-4 away from the house depressions in an area near the bedrock outcrop, as the deposits in this area appeared to be shallower than in the middle of the deposit. Despite the appearance of shallower deposits near the outcrop, the dense and apparently well-stratified deposits at ECS-4 were ultimately too deep to finish excavating by hand, and as mentioned above, an auger was employed below 80 cm. The auger encountered an obstruction at around 120 cm below surface; at the time we were unable to determine whether the obstruction was bedrock, as the deposits down to the obstruction were dense shell midden.

ECS-5 was placed at locus 3, on the western side of the bedrock outcrop at the mouth of a shallow rock shelter. The deposits at locus 3 directly abut the rock face, with a relatively narrow (~ 5 m) flat area in front of the rock shelter above a steep, west-facing slope. The area directly in front of the rock shelter is slightly depressed, initially resembling a house depression or deflation from wind against the rock face. ECS-5 was placed away from the rock shelter face, on the edge of the depression where a low ridge occurs, before the midden deposit drops steeply down the slope face. Three large bedrock mortars occur on the rock outcrop almost directly above the shelter at locus 3 (see Chapter 6). The deposits at ECS-5 appeared less well stratified than at locus 2, but they contained moderate to high densities of shellfish, with several obvious stratigraphic changes. As with locus 2, locus 3 was also too deep to complete an ECS by hand, and an auger was employed beginning at 80 cm. The auger revealed that the deposits at locus 3 extended at least 140 cm below surface, with fragments of regolith apparent in the final auger, suggesting we had encountered bedrock.

Both Sunburst and Brodiaea Ridge are much smaller in extent and depth than Diablo Valdez, requiring only a single ECS at each site. Sunburst contained midden deposits adjacent to the bedrock mortar, and ECS-1 was placed approximately 1 m southwest of the bedrock mortar on a slight slope. Deposits here extended to 40 cm below surface, underlain by bedrock. The deposits at Brodiaea Ridge occur further away from the bedrock mortar itself (~10 m), and ECS-1 was placed on the south-facing slope where midden accumulation appeared to be the most dense. Deposits extended to around 45 cm below surface, underlain by a yellowish brown clayey soil.

Excavation Units. For the Diablo Valdez and Sunburst sites, the methods described below served several purposes: 1) the two adjacent units, one excavated in arbitrary levels and the other stratigraphically, allowed for more accurate excavation of the complicated stratigraphy encountered particularly at Diablo Valdez; 2) the arbitrary units provided a larger overall volume for the recovery of larger artifacts, but the abundant shellfish remains were not collected; 3) the bulk column samples removed from the unit walls provided the majority of the plant data; and, 4) a total of 28 radiocarbon dates, 20 for the Diablo Valdez site alone, allow for a relatively fine-grained analysis of plant use through time at these locations. These excavation methods were based on data provided by the exploratory column samples on stratification and depth of deposits at each site. The excavation methods employed at Brodiaea Ridge were slightly different in that only one 50 x 50 cm unit was excavated stratigraphically due to relatively shallow deposits and simple stratigraphy.

Due to the intact burial encountered at locus 1 at Diablo Valdez, no additional work at this location took place, and instead attention was focused on loci 2 and 3, both of which have deep and well-stratified deposits. At each locus, each of the two adjacent units were 0.5

x 1 m in size. The first 0.5 x 1 m unit (unit 1) was excavated in 10 cm arbitrary levels, although divisions were also based on obvious stratigraphic differences in deposits. All deposits except soil meant for flotation were screened over 1/8-inch mesh. Material collected from this unit included bone, lithic debitage, artifacts, and any obvious charred botanical remains caught in the screen. The remaining material (primarily rock and shellfish) was then discarded onsite and used for backfilling the unit. Sidewall profiles were drawn for each wall prior to excavating the second, adjacent 0.5 x 1 m unit. The second unit (unit 2) was excavated in stratigraphic levels discerned from the sidewall of unit 1 (although strata more than 15 cm thick were divided into arbitrary levels). Bulk soil samples were collected for macrobotanical remains from features encountered during excavation, with sample volume incorporating as much of the feature as possible. Unit 2 material was screened over 1/8-inch mesh on-site, with all material caught by the screens bagged and brought to UC Santa Barbara.

The same excavation methods, entailing two adjacent units, were employed at the Sunburst site. The deposits at this site were much shallower and less complicated than at Diablo Valdez, and the excavation methods employed seemed somewhat inappropriate.

Slightly different excavation methods were used at the Brodiaea Ridge site, as it was determined that the two adjacent units were unnecessary for stratigraphic excavation of the relatively shallow (<40 cm) and largely undifferentiated deposits. Therefore, only one 50 x 50 cm unit was excavated (unit 1). The excavated sediment was screened over 1/8-inch mesh in the field, bagged, and brought back to the laboratory for analysis.

Bulk Column Samples. A single 20 x 20 cm column sample (CS 2) was excavated from a sidewall at each site/locus by stratigraphic level, each bagged as a bulk soil sample

and brought to the Integrative Subsistence Laboratory (ISL) at UC Santa Barbara for flotation processing and analysis. Additional flotation samples were taken from features profiled in the sidewalls but not incorporated by the column sample. Column samples were positioned in an effort to include as many strata as possible, both features and general midden deposits. Once all excavations, profiling and sampling were completed, all units were backfilled with stones collected off-site and screened soil.

**Radiocarbon Dating**

All radiocarbon ($^{14}$C) dates obtained for each site are presented in Chapters 5 and 6. A total of 28 $^{14}$C samples was submitted to Beta Analytic and DirectAMS laboratories in several stages to obtain increasingly better resolution of dated strata. Initial AMS radiocarbon dating was conducted by Beta Analytic, each sample being a single shell of California mussel (*Mytilus californianus*). Samples were collected from all of the ECS units, generally from the surface and basal deposits of each unit to provide preliminary chronological information (Beta-240182, -240183, -282799, -282800, -282801, -282802, -282803). After the primary unit and column sample excavations were complete, additional $^{14}$C samples were submitted to date various features and intervening strata. Because the base of the deposits at Diablo Valdez locus 2 extended approximately 1 meter below the base of the auger sample at ECS-1, a $^{14}$C sample of California mussel was submitted to Beta Analytic to obtain a date from the true base of the site deposit (Beta-332396).

The remaining $^{14}$C samples were all processed via accelerator mass spectrometry by the laboratory at DirectAMS, and included both California mussel and short-lived carbonized plant remains. All dates from the Sunburst and Brodiaea Ridge sites were obtained from

single California mussel shell fragments (DAMS-3963, -3964, -3965, -3966, -6164). Except for two California mussel samples (DAMS-3967, -6165), all remaining $^{14}C$ samples at Diablo Valdez were obtained from short-lived carbonized plant remains, including a manzanita berry pit (DAMS-3976) and brodiaea corms (DAMS-3046, -3047, -3048, -3049, -3050, -3051, -3052, -3972, -3973, -3974, -3975, -3978). Radiocarbon samples were carefully selected from features and general midden contexts that had good stratigraphic integrity. Overall, this suite of dates indicates that these sites were occupied during the last 6000 years. Calibration of radiocarbon ages to calendar years was done using the CALIB 7.0 Radiocarbon Calibration Program (Stuiver and Reimer 2015). Dates are expressed in calibrated years before present (BP) and calibrated calendar ages for dates falling at the end of the Late through Historic Periods.

**Laboratory Methods**

*Excavation Unit Materials.* The material excavated from unit 2 at each Diablo Valdez locus and Sunburst, and unit 1 at Brodiaea Ridge (field screened over 1/8-inch mesh) was transported to the mainland and water screened (washed) at the Collections Processing Laboratory at UC Santa Barbara. To facilitate more efficient sorting in the lab, bulk materials were first size sorted over 1/4-inch and 1/8-inch mesh geological sieves. All archaeological remains from the 1/4" mesh size were sorted into major categories (shell, rock, bone, etc.), while the 1/8-inch materials were sorted for everything except for shellfish and rock. The 1/4-inch shellfish from these unit materials was not sorted beyond general shellfish, although the weight of shellfish remains was recorded for each stratum. The residual 1/8-inch material from each stratum, containing primarily shellfish and rock, was also weighed. Because

volume per stratum was not calculated during excavation due to the complicated stratigraphy, the weight of the shellfish remains for each stratum was used to calculate ratios. Due to the large volume of shellfish and rock recovered from these excavation units, these materials were discarded after weights were recorded. The majority of material was discarded at Campus Point near the Marine Science building, within the rip-rap between the building and the beach.

Lithic artifacts and debitage were pulled from both 1/4-inch and 1/8-inch meshes and identified according to artifact class (debitage, utilized flake, core, microdrills, etc.) and material type. Material types included coarse and fine-grained volcanics, fused shale, siliceous shale, obsidian, chalcedony, and various cherts. Although various chert sources have been noted on the islands, they exemplify a wide diversity in appearance of color, texture and opacity (Jew and Erlandson 2014). As a result, a cautious approach was taken in identifying chert types, described as primarily Santa Cruz Island and Monterey, with general colors and banding noted where applicable. A Santa Cruz Island chert described as "mottled black and white" is notably different in appearance from the other cherts described and is noted when identified. The source of this chert is currently unknown, but has been found in other sites on the northern side of the island, possibly indicating a source on or near the north side. The Monterey chert is also most likely of local origin, possibly from the north side near Cueva Valdez, but is clearly banded.

All other artifacts, including beads, bead detritus, worked bone, red ochre and asphaltum, were pulled from both the 1/4-inch and 1/8-inch mesh sizes. Olivella bead types were identified using the updated California and Great Basin Olivella shell bead guide (Milliken and Schwitalla 2012), based on the Bennyhoff and Hughes (1987) typology. The

temporal association of the bead types described by Milliken and Schwitalla (2012) is based on nomenclature of the Central California Taxonomic System. Therefore, the Early, Middle and Late Period designations typically associated with the bead types identified here do not necessarily correspond with the same cultural period designations in the Santa Barbara Channel region. Rather, calendar years are used in discussions of bead types and their temporal significance on the Channel Islands. Measurements for all beads are provided in the final catalog for this project.

Bone was pulled from both 1/4-inch and 1/8-inch mesh samples and identified to class only, including mammal, bird, fish and rodent. Bone that was unable to be classified was treated separately and labeled unidentified. Most of the mammal bone is sea mammal, although obvious deer or other large terrestrial mammal bone was noted when appropriate. No further effort was made to identify bone to family or genus level for this project, as the primary focus is the relative importance of plant remains to the overall diet. Bone and shell weights are provided for each site, as well as shell to bone weight ratios for each stratum. Rodent bone was not included, as it occurs only in very small amounts. Furthermore, the only rodent that lived on the Channel Islands throughout the Middle and Late Holocene is the deer mouse, and their remains probably entered the site naturally.

Although the primary discussion of the plant remains is based on those recovered through flotation of the column samples, carbonized botanical remains were also recovered from the screened unit excavation material. Wood charcoal was pulled from the 1/4-inch mesh samples only, whereas all other botanical remains were pulled from both 1/4-inch and 1/8-inch mesh samples. Because many botanical remains are small and fragile, they often do not survive the screening process, or are too small to be caught in the screen. However, the

larger volume of unit material compared with the column sample material results in a larger sample of carbonized remains, providing valuable information about larger plant taxa that may not be well represented in the column samples.

*Column Sample Materials.* Volume (in liters) of each stratigraphic division of the column samples was recorded prior to flotation using a large measuring cup. Each sample was then floated using a manual bucket flotation method that entailed decanting into a 0.4 mm fine mesh to collect the light fraction materials. Deflocculation was unnecessary for most samples, but baking soda was used in a few samples with a higher clay content. Each sample was decanted at least three times, until no wood charcoal or other visible plant remains were observed in the final decanting stages. Light fraction materials were then tied up in the fine mesh, labeled, and hung to dry. Heavy fraction materials were spread out and dried on fine window screen mesh (1.0 mm).

Once dry, light fraction materials were size-sorted using nested sieves, resulting in four size grades: 2.0 mm, 1.0 mm, 0.5 mm, and pan (<0.5 mm). Wood charcoal was pulled from the 2.0 mm mesh only, while corm fragments were pulled from both the 2.0 mm, and 1.0 mm mesh sizes, and nutshell was pulled from the 0.5 mm mesh and above. All other charred botanical material including small seeds and seed fragments were separated from all mesh sizes including the pan and identified to the most specific taxonomic category possible. Wood charcoal was not identified as part of this study but has been retained for future study. Subsampling of the light fraction materials was conducted conservatively, generally only in the 0.5 mm size grade and below for some samples. Samples from all strata at all sites were included in the analysis.

The botanical remains, in their complete state, were divided into large and small, with the density per liter of both counts and weights presented for large remains, and density per liter of counts only for small remains. In general, large remains include those that fragment easily (e.g., geophytes, wild cucumber seeds, and acorn nutshell) or are segments of a larger whole (manzanita berry pit segments), whereas small remains typically include whole or nearly whole seeds.

Except for the Sunburst site, the heavy-fraction portions of the column samples were generally not analyzed as part of this project, as the primary focus was on plant remains generally well represented in the light fraction. It is possible that a proportion of plant materials that do not float well (e.g., manzanita berry pits and larger, dense corms) may occur in the heavy fraction sample materials, but these are generally minimal and unlikely to affect the analysis of larger trends in plant use through time. Fragments of both corms and manzanita berry pits were well represented in the light fraction materials and the excavation unit materials. All heavy fraction column sample materials have been retained for future study, as the composition of shellfish and importance of small-bodied fish are of interest but outside the scope of this project.

**Paleoethnobotanical Identification Methods**

All macrobotanical identifications were done with the aid of the comparative collection at UCSB's Integrative Subsistence Laboratory (ISL). Many of the Channel Islands comparative specimens in the ISL have been collected and processed by me as part of my dissertation research. Identification of archaeological specimens were made in consultation with Dr. Amber VanDerwarker (ISL) and Dr. Eric Wohlgemuth of Far Western

Anthropological Research Group. Several pieces of groundstone recovered from Brodiaea Ridge and Diablo Valdez were analyzed for starches by Kristin Hoppa and will be incorporated into her dissertation research. Starch grain analysis would supplement the macrobotanical data, allowing for analysis of plant remains not necessarily preserved in the macrobotanical assemblage.

**Quantitative Analytical Methods**

Several quantitative approaches were employed to interpret the carbonized botanical data from each site, including ubiquity, density, ratios, multivariate analysis, and diversity analysis. Ubiquity analysis, or presence analysis, is useful for expressing within how many of the total number of samples each taxon is present. This can help in presenting the data in a manner that reduces absolute count biases such as differences in preservation, deposition, processing, etc. Because it is based on the number of samples in which a taxon is present, versus the number of specimens of each taxon present in a sample, taxa that are typically not well preserved can be given the same "weight" as taxa which are readily preserved (Hubbard 1976; Popper 1988; VanDerwarker 2010a).

Ratios, often expressed graphically with box plots, are useful for both inter- and intra-site comparisons. Proportions are ratios that compare the importance of one taxon relative to other taxa. They can also be used to show changes in the relative percentage of plant types and community types (habitats) represented in the archaeobotanical assemblage at each site through time (Miller 1988:74; VanDerwarker 2010a). The relative proportions of plant types represented at each site are based on comparisons of plant categories defined by general morphology and toxicity (geophytes, non-toxic nuts/pits, toxic nuts, small seeds, and aquatic

rhizomes). The relative proportion of plant habitats exploited at each site include chaparral, grassland, woodland, wetland, riparian, and mixed. Proportions of plant and habitat types represented are based on count data within each category. The proportions of plant categories represented at each locus is useful for testing hypotheses about plant food ranking.

The independent assessments of plant taxa density through time are best expressed using notched boxplots. Density per liter values were calculated using the raw weight (for large taxa only) and/or count (for all taxa) per sample volume (g/L, n/L). Feature data were excluded from the analysis, as the broader trends in subsistence patterns through time are the primary focus. Standardized values were similarly calculated using raw weights (for large taxa) and count (for small seeds) to total plant weight, excluding wood charcoal. Wood charcoal was excluded in these standardized ratios because the density of wood charcoal increases significantly from the Early to Late Early periods.

Notched box plots also provide an easy visual for comparing statistically significant differences in medians between batches of data, where the notches represent the 95% confidence interval around the median. If the notches of the box plots representing each batch (or time period in this case) do not overlap with the notches of the other box plots, there is a statistically significant difference between the two medians. Conversely, if the notches do overlap, there is no significant difference between batches. The Middle Period was represented by only one sample at Diablo Valdez, and as a result, data from that period appear as a single line representing the median, which is the only value available for each taxon/class. While a single data point is not best summarized using a boxplot (based on a range of data), and cannot be compared with other time periods in a statistically meaningful

way, the value for density within the Middle Period deposit is presented for general comparative purposes.

Diversity analysis, using the Shannon-Weaver index, "incorporates the total number of taxa in an assemblage and the relative abundance of each taxon to express the certainty of predicting the identity of a randomly selected plant remain" (Popper 1988:66; see also VanDerwarker 2010a). In effect, the more diverse the assemblage, the lower the probability of identifying the presence of a randomly selected plant or animal remain, and vice versa. Equitability indicates how evenly the taxa are distributed across taxonomic categories within the assemblage. If there are many taxa in an assemblage, but the majority of remains in the assemblage are of few taxa, the distribution is not "even," indicating both a low diversity and low equitability. Therefore, the higher the diversity value, the more diverse the assemblage is. The equitability index ranges from zero to one, with zero being "least equal" and one being "most equal" (Popper 1988). The usefulness of diversity analysis is that it provides an index of generalized (diverse) versus specialized (not diverse) subsistence strategies, and by extension, site function.

In addition to these quantitative measures, botanical remains can be a good indicator of the seasonal occupation of a site. Determining the season of occupation for archaeological sites based on botanical data alone can be difficult, as plant resources (particularly small seeds and nuts) are often stored for use throughout the winter, with very few taxa indicative of collection during the winter. The seasonal availability of most flowering plants is the blooming period offset by approximately one month to account for the maturation of the seeds. Exceptions to this include pine seeds, acorns and manzanita berries, which take longer to develop after flowering, yet they have well documented maturation and collection times,

indicated in the seasonality charts (Tables 7.2-7.6). Other exceptions are edible brodiaea, which I argue may have been harvested during multiple seasons (Chapter 7).

The various field and laboratory methods described above were designed to produce data relevant for addressing the research questions driving this project. The resulting information about site structure, chronology, artifacts, and faunal remains provides a broader context for the recovery, identification, and quantification of ancient plant remains. These plant remains, in turn, allow for a critical evaluation of previous ideas about island plant resources and their role in decisions about subsistence, settlement, and regional exchange.

# CHAPTER 5

# THE INTERIOR SITES – BRODIAEA RIDGE AND SUNBURST

## The Brodiaea Ridge Site (CA-SCRI-814)

The Brodiaea Ridge site is located just north of Centinela—along Lagunitas Secas Road—at a volcanic rock outcrop approximately 75 m northeast of a cellular tower installed in 2010. On a clear day, extensive views of the Christy watershed to the west and the Central Valley to the east are available. Vegetation in the immediate vicinity of the site consists primarily of open grasslands and chaparral, including Santa Cruz Island buckwheat (*E. arborecens*) and California sagebrush (*Artemesia californica*). Open oak woodland habitat occurs near the site, with a few oaks occurring just downslope of the site boundary and the edge of the dense Bishop pine forest is approximately 350 m to the south. The area immediately southwest of the site, between the site boundaries and the TNC cell site, is a very productive locality for blue dicks. I have been collecting and monitoring changes in their seasonal morphology for several years at this location (see further discussion in Chapter 7). Figure 5.1 shows corms dug in October 2012 after a few minutes using a trowel.

No known springs occur within the immediate vicinity of the site, but the drainage below the site (to the north) generally contains some fresh water. However, the contribution of fog water at this location may be a much more significant contributor to the overall availability of fresh water, as fog water recharges groundwater supplies. As the prevailing coastal fog rolls in from the west, it is pushed upwards as it reaches the Central Valley from the Christy watershed and ultimately results in an increase in fog drip in these interior areas as the water is captured by vegetation (Fischer 2009). The contribution of fog water may help

Figure 5.1. Modern Brodiaea Corms Dug Near Brodiaea Ridge, October 27, 2012 (photo by K. Gill)

account for the high productivity in both the size of individual corms and overall abundance of blue dicks at this particular location.

A sketch map of the Brodiaea Ridge site is shown in Figure 5.1. The east-west trending ridge contains several bedrock outcrops, and steep slopes lead to the drainage to the north. The geologic substrate here is volcanic rock of the Griffith Canyon Member (Tvb-g) described as dark gray-brown flows and flow-breccias of basaltic andesite to olivine basalt; upper part includes basaltic volcaniclastic sediments and mafic tuff-breccias; marine to (Dibblee and Minch 2001). The single bedrock mortar is located on the northern side of the rock outcrop on site overlooking a steep slope down to the north (Figure 5.2). The single

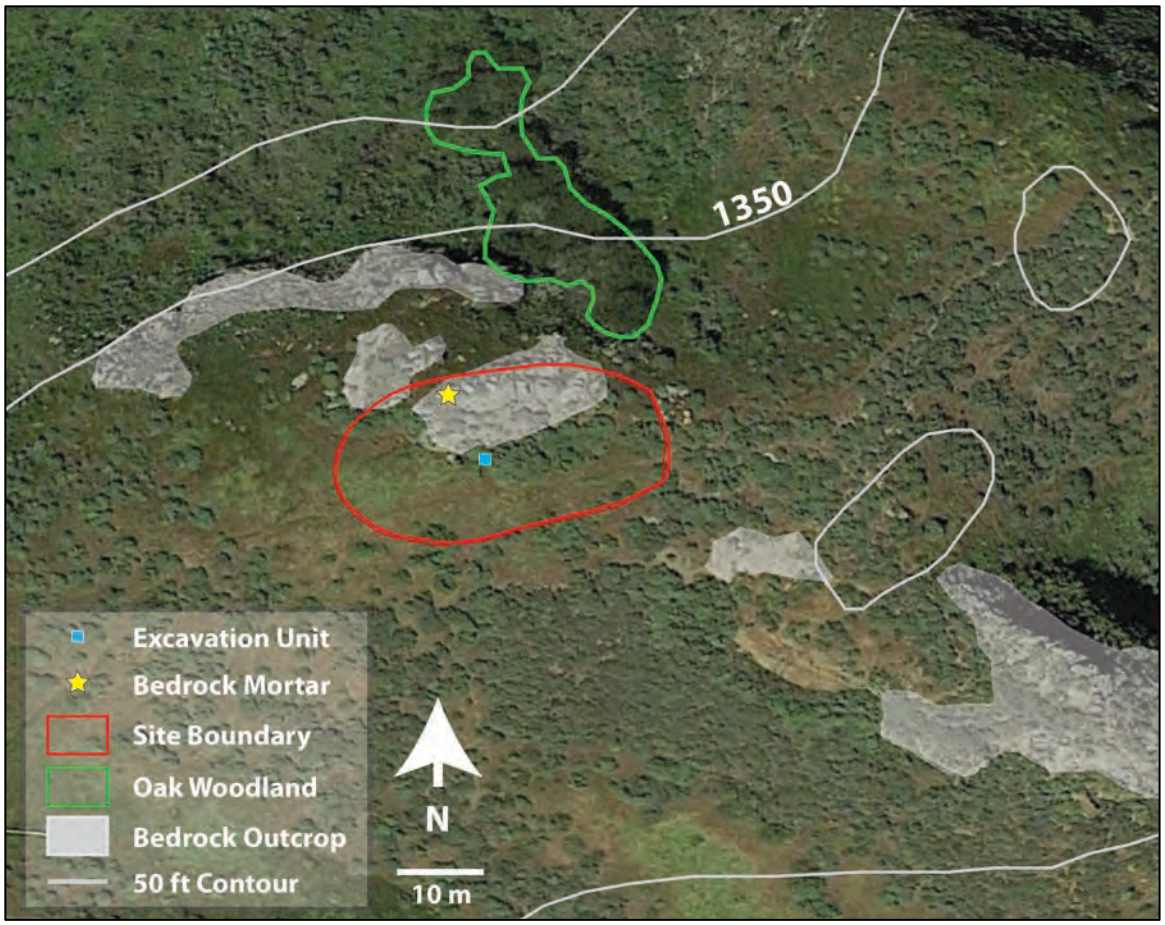


Figure 5.2. Sketch Map of Brodiaea Ridge (CA-SCRI-814), with Google Earth Base (2013)

bedrock mortar present at this site (Figure 5.3) exhibits fairly extensive weathering, which is also seen in the mortars at the Diablo Valdez site but not at Sunburst. The weathering pattern observed here may indicate that this mortar is older than the one at the Sunburst site, or simply that the bedrock at this location is more prone to weathering.

Figure 5.3. Bedrock Mortar at Brodiaea Ridge (photo by A. Roa).

**Soils, Stratigraphy and Site Structure**

In general, Brodiaea Ridge appears to be a relatively shallow site (<50 cm). As discussed in more detail below, the deposits at the site also appear to be mixed. Initial excavation consisted of a small (20 x 20 cm) ECS unit, followed by a larger (50 x 50 cm) excavation unit (unit 1). A summary of the site soils is provided in Table 5.1, including a brief description of each stratum identified in the soil profile along with the depth and dry Munsell soil color. Figure 5.4 presents the soil profile drawing of the west wall of unit 1, with color shading based on the Munsell (dry) soil color chart.

Shellfish density appeared to fluctuate stratigraphically, with the highest density occurring in stratum 2. Thereafter, density gradually decreased with depth, terminating in a mottled light brown clayey sterile soil. As seen at the other two sites, shellfish constituents

Table 5.1. Summary of Soils and Stratigraphy at Brodiaea Ridge, Unit 1, West Wall Profile

| Stratum | Depth | Munsell (dry) | Description |
|---|---|---|---|
| 1 | 0-6 cm | 10YR 3/2 | Dark brownish black silty humus, with low density, highly fragmented shellfish and lithic debitage. |
| 2 | 2-20 cm | 10YR 2/1 | Dark black silty friable soil; higher shellfish and lithic debitage density; larger shellfish fragments |
| 3 | 16-27 cm | 10YR 2/1 | Dark black silty friable soil with increased moisture and clay content than previous strata; Overall lower shellfish density than Stratum 2 |
| 4 | 27-38 cm | 10 YR 2/2 | Dark black soil, slightly more compact than above strata; Decreasing shellfish density |
| 5 | 36-44 cm | 10 YR 3/3 | Very low shellfish density, mottled with sterile, light brown clayey soil. |

consisted primarily of California mussel and acorn barnacle. The strata at this site did not necessarily appear mixed during excavation based on the soils and stratigraphy alone, as varying shellfish densities and fragmentation were observed. However, the stratification at this site was much less well defined and more homogenous compared to that seen at the other two sites. Figure 5.5 shows a photograph of the west sidewall, after excavation of the column sample, as well as the homogeneity of the matrix. It seems likely that the site soils have been partially homogenized by argilliturbation—cyclical shrinking and swelling related to seasonal changes in soil moisture (Wood and Johnson 1978).

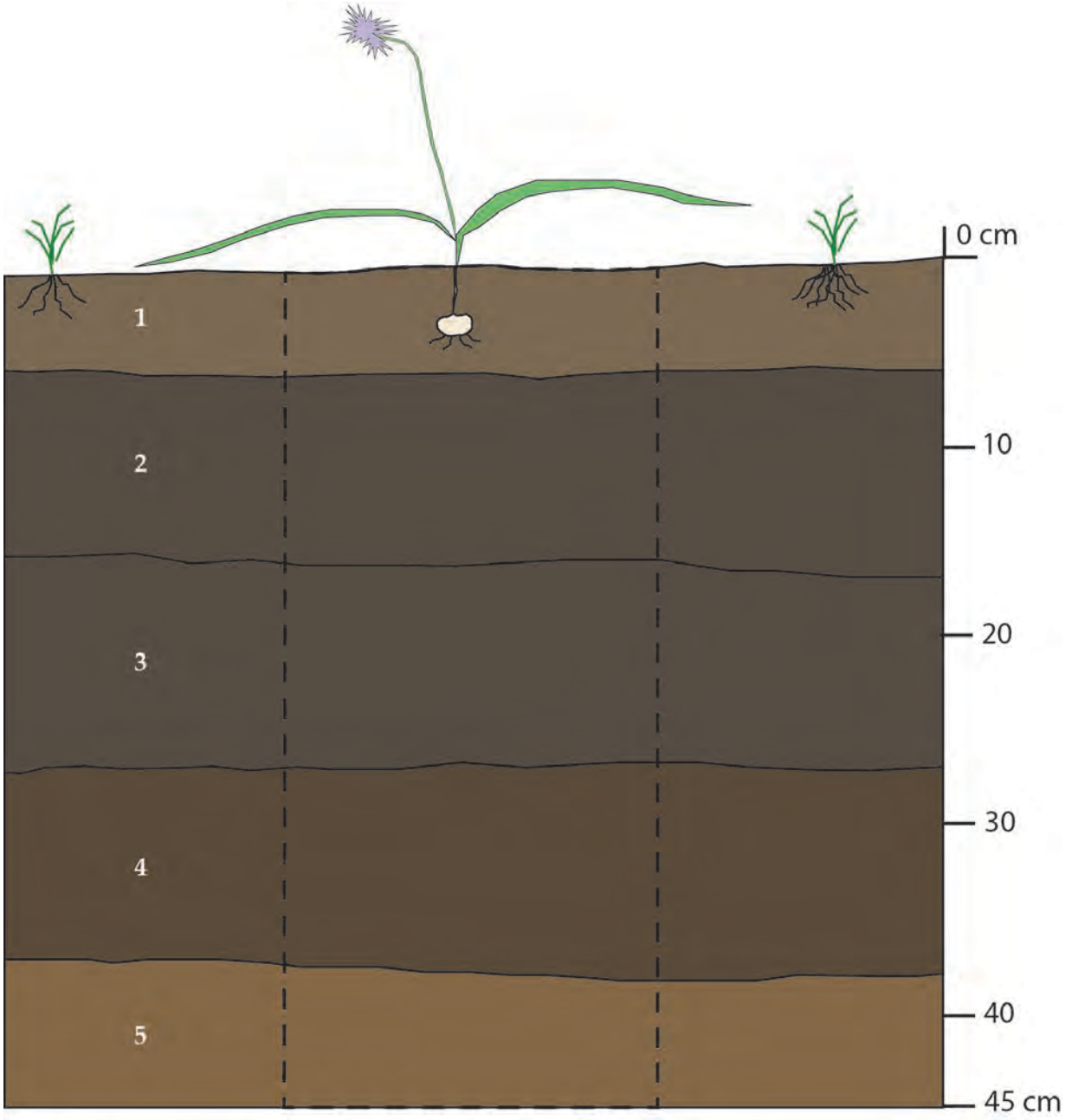


Figure 5.4. Stratigraphic Profile Drawing at Brodiaea Ridge, Unit 1, West Wall.

Figure 5.5. Brodiaea Ridge, West Wall Showing the Relative Homogeneity of the Deposits.

**Site Chronology**

Five $^{14}C$ dates were obtained from this site (Table 5.2). Three of these dates, obtained from the larger excavations in 2013, suggest occupation largely within the last 1,300 years. Two radiocarbon dates obtained from the initial ECS testing indicate a much earlier period of occupation, between 6280 and 4710 cal BP. Although the $^{14}C$ samples came from units placed within close proximity of one another (~ 5 m), the $^{14}C$ dates indicate very different periods of occupation, regardless of depth. Furthermore, a stratigraphic reversal is apparent in the $^{14}C$ dates from unit 1, which was the first clear indication that some mixing of the deposits had occurred. As discussed in more detail below, the artifact assemblage also

Table 5.2. Chronology of Brodiaea Ridge

| Stratum | Depth (cm) | Lab # | $^{14}C \pm \sigma$ | Material | $\delta^{13}C$ | cal BP Age Range (2σ) | cal BC/AD (2σ) | Cultural Period |
|---|---|---|---|---|---|---|---|---|
| 2 | 2-16 | DAMS-3965 | 1038±23 | Mu | -20.5 | 320-480 | AD 1480-1630 | Late Period |
| 3 | 16-27 | DAMS-3966 | 1831±27 | Mu | -26.2 | 1040-1230 | AD 780-910 | Middle Period |
| 5 | 38-39 | DAMS-6164 | 1199±22 | Mu | 1.2 | 500-640 | AD 1310-1450 | Transitional – Late Period |
| CS1 | 0-10 | Beta-282802 | 4340±40 | Mu | 0.6 | 4970-4710 | 3020-2760 BC | Early Period |
| CS1 | 30-40 | Beta-282803 | 5480±40 | Mu | 0.3 | 6280-6000 | 4330-4050 BC | Early Period |

Notes: Mu denotes well-preserved California mussel shell.

suggests stratigraphic mixing, with a relatively uniform distribution of temporally diagnostic artifacts from both the Late and Middle Periods occurring throughout the deposits. While further $^{14}C$ dating may help elucidate the true extent of this stratigraphic mixing, it is clear that these deposits are not entirely intact. One possible source for soil disturbance in this area is that Chumash people may have been digging for brodiaea (blue dicks) corms at this location, mixing the cultural strata. Blue dicks are generally not located very deep in the soil, but the cumulative effect of digging over 6000 years may have resulted in the movement of a fairly substantial amount of soil.

Although not represented in the $^{14}C$ dates for unit 1, it is probable that Early Period deposits are mixed with Middle, Transitional, and Late Period deposits at this unit as well at the ECS. If so, this would mean that the mixed cultural deposits represent occupation over 6000 years, making it impossible to examine subsistence practices through time. In the following discussion, data are presented by stratum rather than by time period. Despite the evidence for stratigraphic mixing, this site still provides valuable information. It is apparent,

however, that people occupied this interior site repeatedly over the last 6000 years, a pattern similar to the Diablo Valdez site, albeit on a significantly smaller scale.

**The Artifacts**

Several temporally diagnostic artifact types were recovered from Brodiaea Ridge in various strata, further indicating previous soil movement/disturbance. Chipped stone artifacts include debitage, utilized flakes, projectile points, and both triangular dorsally retouched (TDR) and trapezoidal microdrills/blades (Table 5.3). Trapezoidal microdrill/blade technology was in use primarily during the terminal Middle Period and into the Late Period. However, TDR microdrill/blade technology typically occurs only during the Late Period and

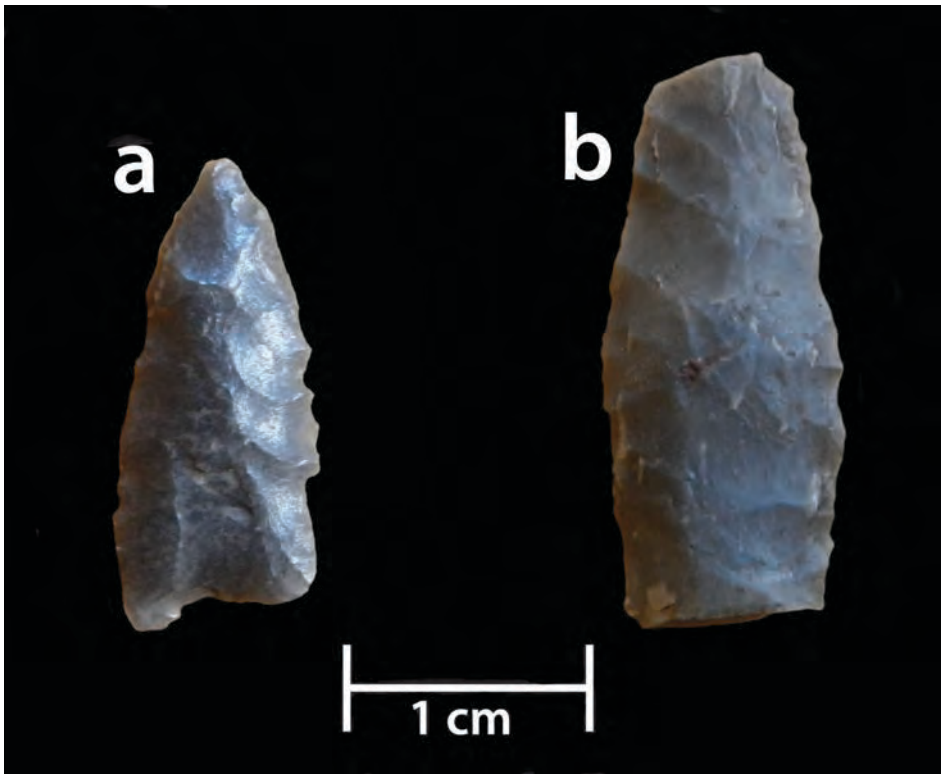


Figure 5.6. Brodiaea Ridge Projectile Points; a) Fused shale point, stratum 3; b) SCRI chert point, surface.

tends to be associated with callus cupped olivella bead production (Arnold et al. 2001; Preziosi 2001). A total of 46 TDR microdrills were recovered from all cultural strata at this site, including those deposits radiocarbon dated to the Middle Period (see Table 5.3). A small fused shale projectile point, was recovered from stratum 3, dated to the Middle Period (Figure 5.6).

Across the island, similar fused shale points are typically associated with Late Period deposits and are often found on the surface of sites. Fused shale does not occur on the islands, and the nearest source is on the mainland near Ventura. Except for fused shale, lithic material types are largely comprised of locally available sources, including Santa Cruz Island (SCRI) chert, coarse and fine-grained volcanics, chalcedony, siliceous shale, quartzite, and Monterey chert (Table 5.3). As discussed in Chapter 4, the Monterey Formation occurs near Cueva Valdez on the north side of the island, and the presence of both Monterey chert and siliceous shale debitage at this site suggests a local source rather than import from the mainland. Known chert quarries on Santa Cruz Island occur primarily on the east end (Perry and Jazwa 2010), although additional chert sources—in the form of cobbles and veins—have been observed at various locations on the island (personal observation; Jon Erlandson, personal communication 2014).

Table 5.3. Summary of Artifact Counts at Brodiaea Ridge, Unit 1, by Stratum

| Type | Material | Stratum | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| **Time Period*** | | **?** | **LP** | **MP** | **?** | **LP** |
| *Chipped Stone Artifacts* | | | | | | |
| Projectile Point | SCRI Chert (Surface) | 1 | -- | -- | -- | -- |
| Projectile Point | Fused Shale | -- | -- | 1 | -- | -- |
| Microdrill – TDR | SCRI Chert | 3 | 14 | 18 | 10 | 1 |
| Microblade – TDR | SCRI Chert | -- | 29 | 14 | -- | -- |
| Microdrill – Trapezoidal | SCRI Chert | -- | -- | 4 | 3 | -- |
| Microblade – Trapezoidal | SCRI Chert | -- | 1 | 3 | 3 | -- |
| Macrodrill | Volcanic | -- | -- | -- | 1 | -- |
| Macrodrill | SCRI Chert | -- | -- | -- | 1 | -- |
| Utilized Flake | Fine Grained Volcanic | -- | 1 | 1 | -- | -- |
| Utilized Flake | SCRI Chert | -- | 1 | 1 | -- | -- |
| Debitage | Chalcedony | 1 | 1 | -- | -- | -- |
| Debitage | Fine Grained Volcanic | 6 | 17 | 7 | 11 | 3 |
| Debitage | Volcanic | -- | -- | 1 | -- | -- |
| Debitage | SCRI Chert | 11 | 41 | 21 | 20 | 6 |
| Debitage | Monterey Chert | -- | 1 | 2 | 2 | 1 |
| Debitage | Quartzite | -- | 1 | 2 | 2 | -- |
| Debitage | Siliceous Shale | -- | -- | 2 | -- | -- |
| *Groundstone Artifacts* | | | | | | |
| Bowl mortar/chopper | Fine Grained Volcanic | -- | -- | 1 | -- | -- |
| *Beads* | | | | | | |
| Bead | *Haliotis rufescens* | -- | -- | 1 | -- | -- |
| Bead | *Mytilus* sp. | -- | -- | 2 | 1 | -- |
| Callus cupped bead (K1) | Olivella | -- | 1 | 1 | -- | -- |
| Tiny saucer bead (G1) | Olivella | -- | -- | 2 | -- | -- |
| Bead in Production (BIP) | Steatite | -- | -- | 1 | -- | -- |
| Wall BIP | Olivella | -- | -- | -- | 1 | -- |
| BIP/Blank | *Tivela* | -- | 4 | 1 | 1 | -- |
| Bead detritus | Olivella | -- | 3 | 2 | 5 | -- |
| Bead detritus | *Tivela* | 2 | 101 | 68 | 30 | -- |
| *Other* | | | | | | |
| Mineral | Asphaltum | -- | 2 | -- | -- | -- |
| Mineral | Red Ochre | -- | -- | -- | -- | 1 |

* LP=Late Period; MP=Middle Period; Early Period deposits not known from unit 1 but may occur

The bead assemblage at this site also supports the interpretation that the deposits are mixed (Table 5.3, Figure 5.7c). Two callus cupped (K1) and two tiny saucer (G1) olivella beads were recovered, and these are diagnostic to the Late Period. However, three of the four were recovered from deposits radiocarbon dated to the Middle Period in stratum 3. Other bead types diagnostic to both the Middle and Late Periods (King 1990) include three tiny

burned California mussel beads (Figure 5.7, b), an abalone bead (Figure 5.7, d), and a broken steatite bead in production (not shown). Although no finished Pismo clam (*Tivela*) beads were found at this site, six shell beads in production (or blanks) and high counts of detritus were identified throughout the deposits (Table 5.3, Figure 5.7, a). In fact, counts of Pismo clam detritus are significantly higher (n= 201) than olivella detritus (n=10). Clam disc beads are diagnostic to the Early and Late Periods but do not appear to have been used during the Middle Period (King 1990).

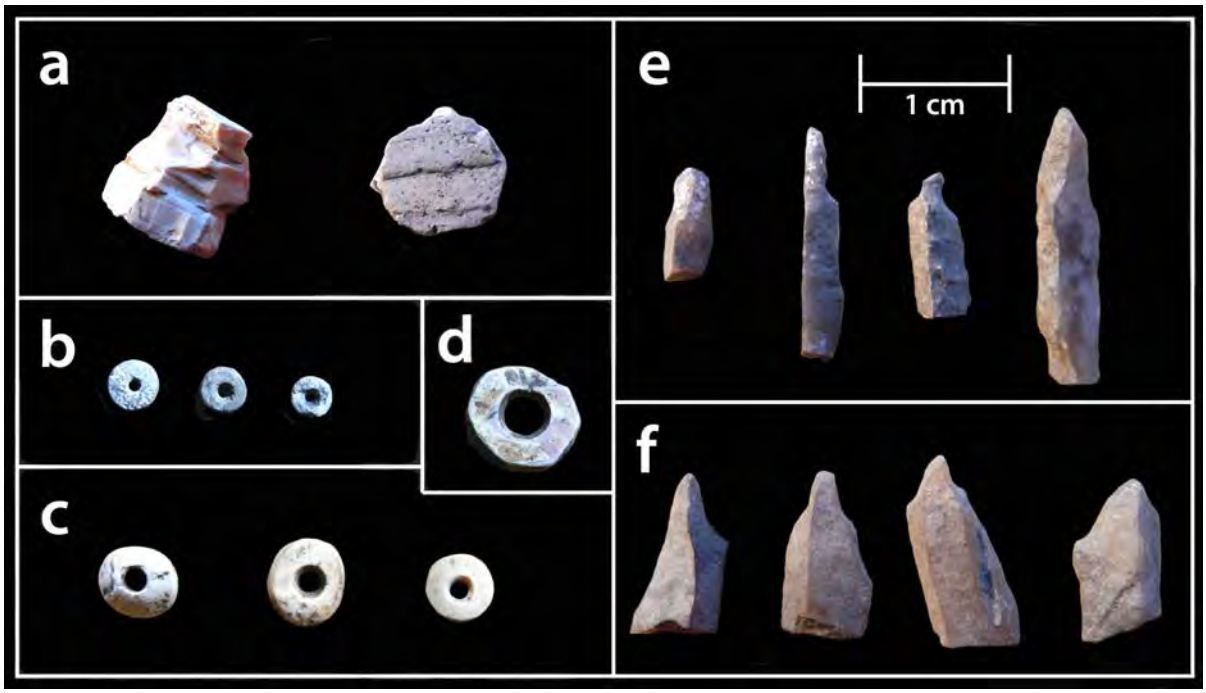


Figure 5.7. Brodiaea Ridge Bead and Microdrill Artifacts; a) *Tivela* beads in production; b) Burned *Mytilus* beads; c) Callus cupped (K1) (left two) and tiny saucer (G1) Olivella beads; d) Abalone bead; e) Santa Cruz Island chert, TDR microdrills; f) Santa Cruz Island chert, trapezoidal microdrills.

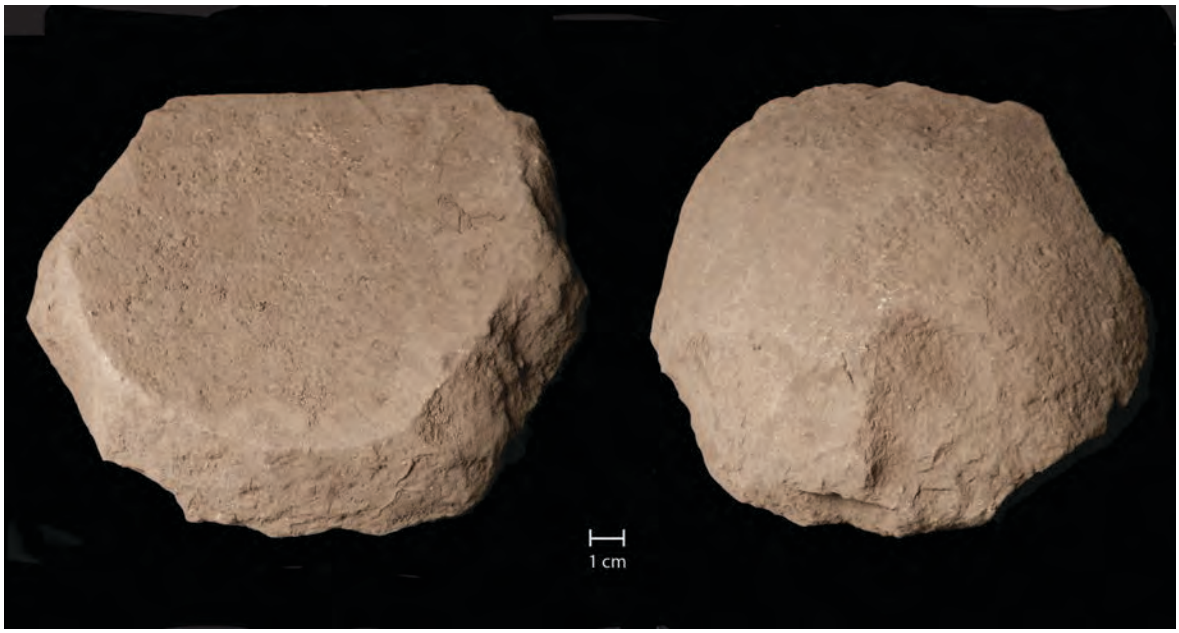


Figure 5.8. Bowl Mortar Fragment Used as a Hammerstone/Chopper, Unit 1, Stratum 3.

No bone artifacts were identified at this site, although both red ochre and asphaltum were recovered in very small amounts. One bowl mortar fragment (Figure 5.8) was found in situ (stratum 3) during the excavation of unit 1. This mortar fragment also appears to have been used as a hammerstone/chopper after the bowl broke into pieces. Because it was found buried, this bowl fragment was tested for starch grains by Kristin Hoppa in the Integrative Subsistence Laboratory at UC Santa Barbara, but unfortunately none have been recovered so far.

**Faunal Remains**

*Shellfish*

Although no shellfish data were quantified, the shellfish remains are similar to the other sites, comprised primarily of California mussel and acorn barnacle. Pismo clam occurs in apparently larger quantities at this site compared with either Diablo Valdez or Sunburst,

however, and is present in all but the lowest stratum. In contrast to the mussel and barnacle that dominate the rocky intertidal zone, Pismo clams live in sandy substrates, which may indicate the site occupants made regular forays to a sandy beach. There are several pocket beaches along the north coast that may support populations of Pismo clam, although the Christy Beach area to the west may be the best candidate, as large amounts have been identified at several archaeological sites in that area as well, including SCRI-480 at Christy Beach (Thakar 2011, 2014).

*Bone*

Because volume per stratum was not recorded during excavation, raw weights of shellfish and each class of bone, as well as the relative proportion (ratio) of the weight of shellfish to bone for each stratum is summarized in Table 5.4. The majority of the mammal bone is comprised of sea mammal, with no obvious deer or other large terrestrial mammal bone noted. All shellfish and bone weights reported here were recovered from the 1/8-inch screened unit 1 material. As a result, bones from very small-bodied fish are probably not well represented. In general, it appears that the total shell:bone weight ratios at Brodiaea Ridge show that shellfish was an important component of the faunal diet, with sea mammal, bird, and fish also consumed.

Table 5.4. Brodiaea Ridge Bone and Shell Weight (g) Ratios

| Stratum | Shell (g) | Mammal (g) | Bird (g) | Fish (g) | Shell:Bone |
|---|---|---|---|---|---|
| 1 | 920 | 1.16 | -- | 0.11 | 724:1 |
| 2 | 4900 | 4.65 | 0.63 | 4.17 | 519:1 |
| 3 | 2600 | 4.02 | 0.36 | 3.09 | 348:1 |
| 4 | 3300 | 1.87 | 0.73 | 4.11 | 492:1 |
| 5 | 820 | -- | -- | 0.66 | 1242:1 |

**Paleoethnobotanical Remains**

Despite the relatively small size of my excavations and flotation samples at the Brodiaea Ridge site, carbonized remains of at least 20 plant taxa were recovered, most of which are edible. While the primary discussion of the paleoethnobotanical remains is based on those recovered through flotation of the column samples, they were also recovered in the 1/8-inch screened material, including wood charcoal, brodiaea corm fragments, and manzanita berry pits (Table 5.6). However, the amount and diversity of plant remains recovered from the 1/8-inch screened material is small in comparison to those recovered using flotation techniques.

Table 5.6. Brodiaea Ridge Botanical Remains, Unit 1, 1/8-inch Screened Material

| Stratum | Wood Charcoal (g) | Brodiaea Corm (g) | Manzanita Pit (g) |
|---|---|---|---|
| 2 | 0.82 | 0.03 | -- |
| 3 | 0.97 | 0.32 | <0.01 |
| 4 | 0.71 | -- | 0.06 |
| 5 | -- | 0.11 | 0.09 |

Given the relatively large size and general hardiness of wood charcoal, brodiaea corms, and manzanita berry pits, it is not surprising these remains were recovered in the screened material. Other large taxa, such as acorn and wild cucumber, tend to break into smaller pieces and are generally more fragile than corms or manzanita pits. As a result, they are likely underrepresented in the screened materials, particularly when compared with taxa recovered in the light fraction column samples. The greater recovery of paleoethnobotanical remains in light-fraction column samples is no surprise; it highlights the importance of using flotation of bulk soil samples to recover small and fragile plant remains.

*Light Fraction Column Samples*

The column sample at Brodiaea Ridge had a total volume of 19.5 liters. Table 5.7 presents the density per liter of all archaeobotanical remains for each stratum recovered from the light fraction, and raw counts and weights are provided in Appendix B. Overall, the archaeobotanical assemblage indicates the use of locally available plant foods, including manzanita berry pits, brodiaea corms, a small amount of acorn, lemonade berry, island barberry, and various small seeds. These taxa largely reflect the habitat types situated near the site today, including open grassland, chaparral, and oak woodland. Detailed ethnographic information concerning these plant remains and further analysis of paleoethnobotanical remains and their significance are presented in Chapter 7. As discussed above, a detailed analysis of change in plant use through time at this site is not possible due to the stratigraphic mixing. However, general trends can be examined, including a comparison of general plant categories, habitat types, ubiquity, and seasonality for the site as a whole, useful for understanding the general nature of terrestrial plant use at this location.

Table 5.7. Density of Archaeobotanical Remains at Brodiaea Ridge*

| **Stratum** | | | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **0-6** | **6-16** | **16-27** | **27-35** | **35-39** |
| **Volume (liters)** | | | **3.00** | **4.75** | **5.50** | **4.50** | **1.75** |
| Large Taxa | | | | | | | |
| **Genus** | **Name** | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | 0.21 | 0.36 | -- | -- |
| | | g | -- | 0.001 | 0.001 | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | -- | 0.63 | 0.73 | 5.56 | -- |
| | | g | -- | 0.011 | 0.004 | 0.033 | -- |
| *Marah* spp. | Wild Cucumber | n | -- | 0.21 | 0.18 | 0.44 | -- |
| | | g | -- | 0.001 | 0.001 | 0.001 | -- |
| *Quercus* spp. | Acorn | n | -- | -- | 0.55 | -- | 0.57 |
| | | g | -- | -- | 0.001 | -- | 0.003 |
| UnID Nutshell | | n | 0.67 | -- | -- | -- | 0.57 |
| | | g | 0.002 | -- | -- | -- | 0.006 |
| Wood Charcoal (2.0 mm) | | g | 0.007 | 0.1 | 0.16 | 0.16 | 0.02 |
| Small Taxa | | | | | | | |
| **Taxon** | **Name** | | | | | | |
| *Berberis* sp. | Island Barberry | n | -- | -- | -- | 0.22 | -- |
| *Bromus* spp. | Brome Grass | n | -- | -- | 0.18 | -- | -- |
| *Eleocharis* sp. | Spikerush | n | -- | 0.21 | 0.18 | -- | -- |
| *Eriogonum* spp. | Buckwheat | n | -- | 0.21 | 0.55 | 0.44 | -- |
| *Galium* spp. | Bedstraw | n | -- | 0.42 | 0.18 | -- | -- |
| *Hemizonia* spp. | Tarweed | n | -- | 0.21 | 0.55 | 0.44 | -- |
| *Lotus scoparius* | Deerweed | n | -- | 0.21 | -- | -- | -- |
| *Peritoma* spp. | Bladderpod | n | -- | 0.21 | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | 0.21 | -- | -- | 0.57 |
| *Potamogeton* | Pondweed | n | -- | -- | -- | -- | 0.57 |
| *Rhus integrifolia* | Lemonade Berry | n | -- | -- | 0.18 | -- | -- |
| *Salvia* spp. | Chia, Sage | n | -- | 0.42 | 0.18 | -- | -- |
| *Sambucus* sp. | Elderberry | n | -- | -- | 0.18 | -- | -- |
| *Trifolium* spp. | Clover | n | -- | -- | 0.18 | 0.67 | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | -- | -- | -- | 0.57 |
| Fabaceae | Bean Family | n | -- | -- | -- | -- | 1.14 |
| Poaceae | Grass Family | n | 0.67 | 2.53 | 0.18 | 0.22 | -- |
| Amorphous | | n | -- | 1.26 | -- | 2.22 | -- |
| | | g | -- | -- | -- | -- | -- |
| UnID Plant Tissue | | n | -- | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- | -- |
| Unidentified Seeds | | n | 1.33 | 0.63 | 0.73 | 2.0 | 0.57 |
| Unidentified Seed Fragments | | n | -- | 3.79 | 4.0 | 3.56 | 4.57 |
| Total Identified to Genus | | n | -- | 2.1 | 2.36 | 1.77 | 1.14 |
| Total Identified to Family | | n | 0.67 | 2.53 | 0.18 | 0.22 | 1.71 |

* Large taxa include values for count and weight, small taxa by counts alone.

**The Sunburst Site (CA-SCRI-813)**

The Sunburst site is located approximately 275 m south of the base of the trail leading up to Diablo Peak, at a small rock outcrop on the southern slope of the northern range. Vegetation surrounding the site consists of open grasslands interspersed with Santa Cruz Island buckwheat (*Eriogonum arborescens*) and the occasional coyote brush (*Baccharis pilularis*), prickly pear cactus (*Opuntia* sp.), and introduced mustard (*Brassica nigra*). Oak woodland also occurs on the north-facing slope immediately south and southeast of the site, which was likely present during the time of site occupation as well (Figure 5.9). A sketch map of the Sunburst site is shown in Figure 5.10.

Figure 5.9. T. Joslin at the Sunburst Site Facing Southeast, with Dense Fog Bank in the Distance (photo by K. Gill).

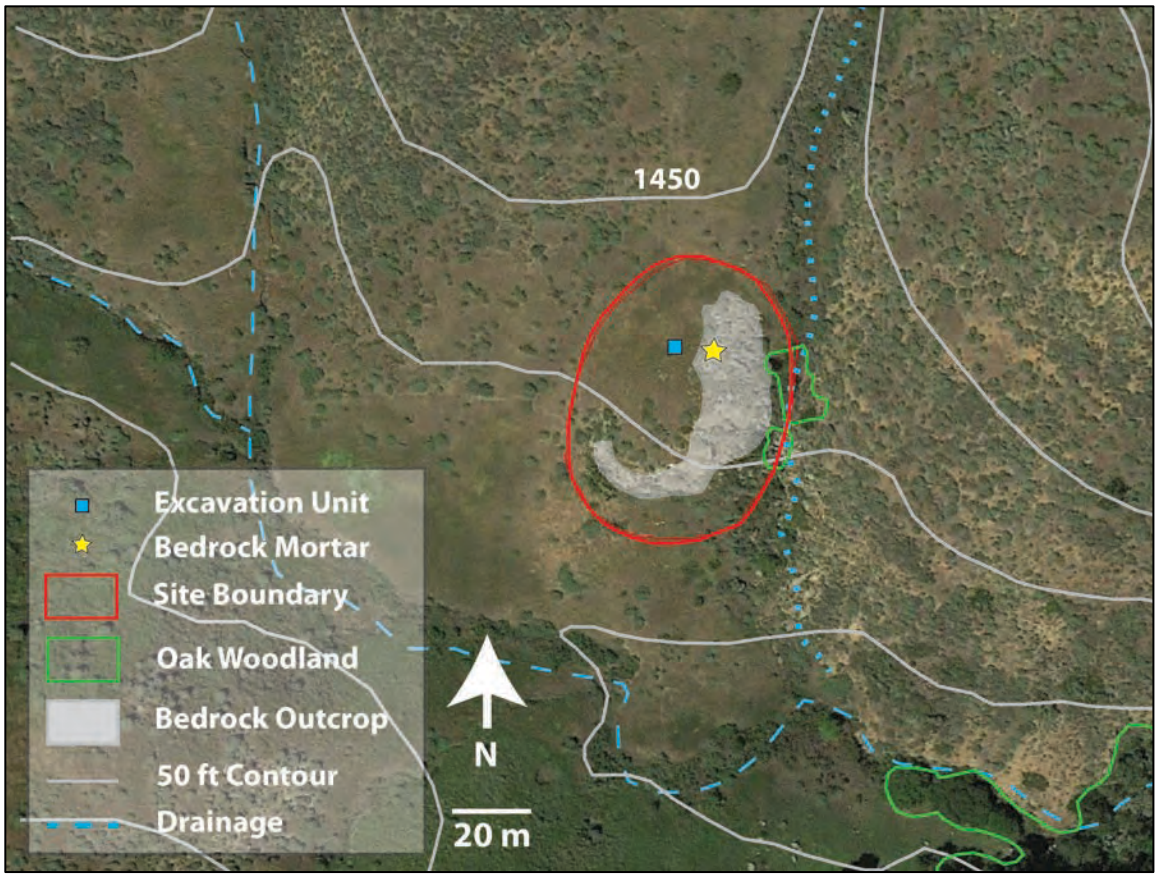


Figure 5.10. Sketch Map of Sunburst (CA-SCRI-813), Google Earth Base (2013)

A small spring occurs in the small drainage adjacent to and just west of the site (drainage indicated by the small dashed line in Figure 5.10), which may have been an important factor in choosing this location for habitation. The contribution of fog water may also have been important for recharging the groundwater through fog drip, particularly when it settles low into the interior valleys (see Figure 5.9). However, the fog at this location seems to burn off relatively quickly in the mornings when it is not blanketing the entire island, and the direct contribution of fog drip to fresh water availability may not have been as significant here as in other areas.

Santa Cruz Island volcanics are the geological substrate of the northern ridge. The bedrock outcrop at Sunburst is similar in appearance to that seen at the other two sites, although the bedrock mortar here is much better preserved. Although it is possible there is some difference in hardness of the bedrock itself, the excellent preservation of this mortar is probably more likely related to the later occupation of this site (see Figure 5.11).

Figure 5.11. Bedrock Mortar at Sunburst (CA-SCRI-813), with Prickly Pear Cactus in the Foreground and Island Buckwheat at Upper Left (photo by K. Gill).

**Soils, Stratigraphy, and Site Structure**

Deposits at Sunburst are relatively shallow, with only two strata encountered in the unit excavations. Excavation units were located on a slight slope near the bedrock mortar in

an area of medium to high shellfish density. Stratum 1 is between 4 and 7 cm thick, and consists of medium brown silty loam soil with highly fragmented shellfish consisting primarily of California mussel and barnacle. Stratum 2 is differentiated from Stratum 1 in that there is an increase in whole and larger fragments of shellfish, and the soil appears to be more compact yet is still a medium brown silty loam. The density of shellfish decreases significantly towards the base of the stratum, where it transitions to largely sterile deposits (stratum 3) that are lighter in color and compact, and contain a proportionately large amount of decomposing volcanic bedrock. Only a very sparse amount of shellfish occurs in the lowest stratum, and it is possible that cultural materials have moved downward into this stratum via argilliturbation. During the time of initial occupation at the site, a thin layer of

Figure 5.12. Sunburst Site (SCRI-813) Unit 1, North Wall (photo by T. Joslin).

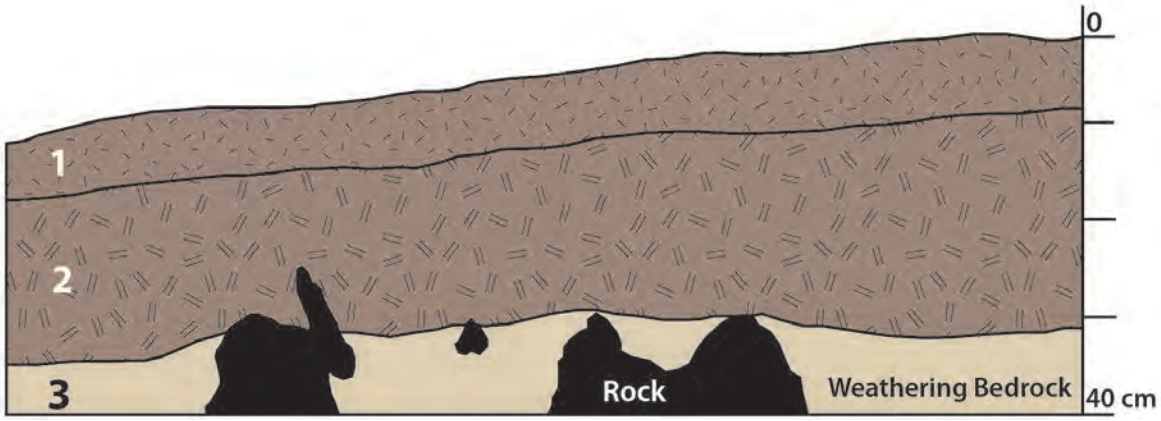

Figure 5.13. Stratigraphic Profile Drawing at Sunburst, Unit 1, North Wall

soil apparently had accumulated directly on top of decomposing bedrock, with cultural deposits occurring above. Shellfish constituents consist primarily of California mussel and large barnacle, similar to the other sites examined. Table 5.8 provides the stratigraphic description and Munsell color (dry) for the strata encountered in unit 1, corresponding to the strata shown in Figure 5.13. Depths were measured from a datum plane at the elevation

Table 5.8. Summary of Soils and Stratigraphy at Sunburst, Unit 1, North Wall

| Stratum | Depth | Munsell (dry) | Description |
|---|---|---|---|
| 1 | 3-12 cm | 10YR 2/2 | Very dark brown silty humus, with medium density of high fragmented shellfish. |
| 2 | 12-27 | 7.5YR 2.5/1 | Black silty loam soil, with increased shellfish density and increased whole and nearly whole shells, slightly more compact than previous stratum. |
| 3 | 27-40 | 10YR 3/2 | Very dark grayish brown silty loam, moderately compact, with a decrease in shellfish density and an increase in decomposing bedrock. |

of the northeast corner of the unit to account for slope, with the excavation following stratigraphic variation. No features were encountered during excavation at this site, and it appears to be a largely ephemeral and single-component deposit.

**Site Chronology**

Three $^{14}C$ dates were obtained from the Sunburst site and are presented in Table 5.9. One date (ECS, 20-30 cm) was obtained during initial sampling efforts, corresponding with stratum 2 identified during subsequent excavation. The other two dates both came from unit 2 excavation materials for strata 1 and 2. These cultural strata were easily defined during excavation, and the calibrated age ranges correspond well with the date obtained from CS1, excavated 1 m south of the main excavation units.

Table 5.9. Chronology of the Sunburst Site

| Stratum | Depth | Lab # | $^{14}C \pm \sigma$ | Material[1] | $\delta^{13}C$ | $^{14}C$ cal B.P. Age Range ($2\sigma$) | $^{14}C$ cal A.D. Age Range ($2\sigma$) | Cultural Period[2] |
|---|---|---|---|---|---|---|---|---|
| 1 | 3-12 cm | DAMS -3964 | 1144±23 | Mu | -3.3 | 450-550 (*p=1*) | AD 1400-1500 | LP |
| 2 | 12-27 cm | DAMS -3963 | 1336±21 | Mu | 4.3 | 560-690 (*p=1*) | AD 1260-1390 | TP – LP |
| ECS | 20-30 cm | Beta-282801 | 770±40 | Mu | -0.6 | 510-680 (*p=1*) | AD 1270-1440 | TP –LP |

[1] Mu – CA Mussel; [2] TP – Transitional Period, LP – Late Period

Overall, occupation at this site appears to have occurred during the Transitional (AD 1150-1300) to Late Periods (AD 1300-1782). Radiocarbon dates for stratum 1 may indicate a slightly later occupation than stratum 2, although the two-sigma intercept range of the radiocarbon date from the ECS overlaps with the ranges for both strata at unit 2. Therefore it is possible that this site was occupied repeatedly beginning around AD 1150, or it is a single component site occupied during a relatively brief period of time during or just after the Transitional Period. Temporally diagnostic artifacts support the chronometric data.

## The Artifacts

The artifacts recovered from Sunburst include chipped stone, groundstone, and shell artifacts, as well as a small amount of red ochre (Table 5.10). Forty-two triangular dorsally retouched (TDR) microdrills/blades, temporally diagnostic to the Transitional and Late Periods, were recovered in relatively high counts from unit 2. Six trapezoidal microblades

Table 5.10. Summary of Artifact Counts at Sunburst, Unit 2, by Stratum

| Type | Material | Stratum | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| *Chipped Stone Artifacts* | | | | |
| Microdrill – TDR | SCRI Chert | 2 | 18 | -- |
| Microblade – TDR | SCRI Chert | 4 | 18 | -- |
| Microblade – Trapezoidal | SCRI Chert | -- | 6 | -- |
| Scraper | SCRI Chert | -- | 1 | -- |
| Utilized Flake | Fine Grain Volcanic | -- | 1 | -- |
| Debitage | SCRI Chert | 5 | 61 | 5 |
| Debitage | Monterey Chert | -- | 1 | -- |
| Debitage | Fine Grain Volcanic | 3 | 28 | -- |
| Debitage | Chalcedony | -- | 5 | -- |
| Debitage | Quartzite | -- | 2 | 1 |
| *Groundstone Artifacts* | | | | |
| Groundstone fragment | Sandstone | -- | 1 | -- |
| *Shell Artifacts* | | | | |
| Incised split drilled bead (C2i) | Olivella | -- | 1 | -- |
| Bead in production | Olivella | 1 | -- | 1 |
| Bead detritus – wall | Olivella | 21 | 157 | 13 |
| Bead detritus – spire | Olivella | 5 | 13 | 5 |
| Bead detritus – callus/columella | Olivella | 6 | 52 | 9 |
| Bead blank | *Tivela* | -- | -- | 1 |
| Detritus | *Tivela* | 5 | 37 | 9 |
| *Other* | | | | |
| Mineral | Red Ochre | -- | 1 | -- |

were recovered, although no trapezoidal drills were found. Trapezoidal microdrills/blades were used initially during the Middle Period and were largely replaced by TDR microdrills/blades during the Transitional Period, but not entirely (Preziosi 2001). One small scraper of SCRI chert was identified, as well as a single utilized flake made from a fine

grained volcanic rock. As seen at the Diablo Valdez site (see Chapter 6), chipped stone artifacts and debitage materials are primarily of local origin, consisting predominately of SCRI chert, followed by fine-grained and coarse-grained volcanics. Less abundant material types include chalcedony, quartzite, and Monterey chert. Several pieces of debitage and one TDR microdrill (Figure 5.13 (d), third from the right) made of SCRI chert are mottled black and white in color with a notable sheen that appears to be the result of heat alteration. This material type has been found at all three sites included in this research project, although the color is somewhat unusual for SCRI chert. One small fragment of sandstone groundstone was identified in stratum 2, although it is too small to determine whether it is a bowl or metate fragment. There are no sandstone outcrops in the immediate vicinity of the site, as the surrounding substrate is volcanic. However, sandstone substrates do occur between approximately 3 and 8 kilometers southwest of the site. No projectile points or other formal chipped stone artifacts were identified.

Shell artifacts from unit 2 include both olivella and Pismo clam (*Tivela*) bead detritus. One Pismo clam bead in production was recovered, along with 51 pieces of clam detritus. As discussed previously, the presence of Pismo clam detritus at this site suggests the site occupants were visiting and/or connected with areas of the island that support Pismo clam populations, possibly in the Christy Beach area. While these are raw counts, the Brodiaea Ridge site also contained a relatively large amount of Pismo clam (n=201), whereas very little (n=7) was recovered from Diablo Valdez. Olivella bead detritus was recovered in large quantities here (n=281), along with two olivella beads in production (BIPs). However, finished olivella beads are notably and somewhat surprisingly absent in the assemblage. The largest proportion (67.97%) of the olivella detritus recovered comes from the wall portion of

the olivella shell, with much smaller amounts of the callus/columella (23.84%) and spire portions (8.19%) of the shell. The large proportion of wall to callus detritus, combined with the dearth of finished olivella beads and high counts of TDR microdrills at the site, suggests that bead production occurred at this site, with the finished beads taken elsewhere, a pattern also observed at sites inland of Coches Prietos on the island's south side (Peterson 1994).

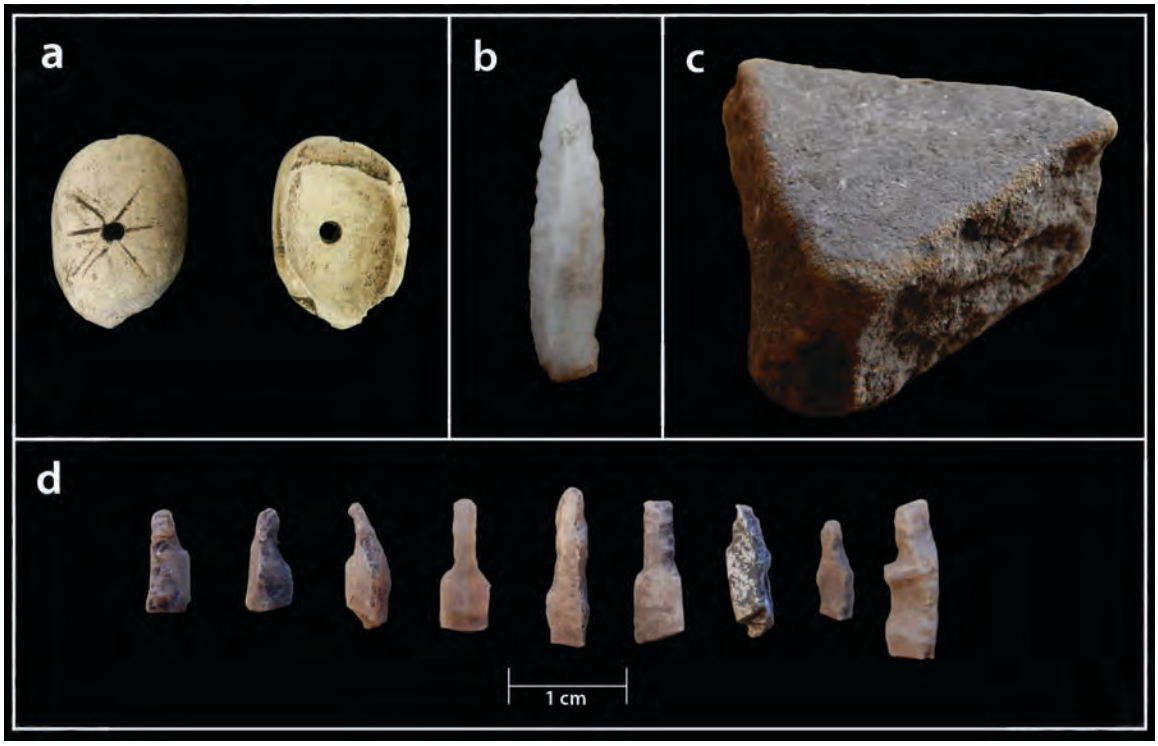


Figure 5.14. Sunburst Bead, Microdrills, and Groundstone Artifacts; a) Incised split drilled olivella bead (C2i) with "sunburst" incision pattern; b) SCRI chert trapezoidal microblade with use-wear; c) Sandstone groundstone fragment; d) Sample of SCRI chert TDR microdrills.

Figure 5.14 presents several artifact types recovered from the Sunburst site, including a split drilled (C2i) bead incised with a "sunburst" pattern (a), a trapezoidal microblade with use-wear (b), a fragment of sandstone groundstone (c), and a sample of the TDR microdrills made of SCRI chert, including the black and white mottled material (third from the right) (d).

The incised sunburst bead presented in Table 5.10 and shown in Figure 5.13 (a), was recovered from unit 1 and is the only artifact from unit 1 described. It is discussed in detail here, as this bead type is apparently rare, with an incision pattern different from that described by Bennyhoff and Hughes (1987) or Milliken and Schwitalla (2012). The C2i bead type is based on only two examples from the Great Basin, incised with chevron designs, and as noted by Milliken and Schwitalla (2012:26), it "should not be confused with any other bead type." However, the bead found at the Sunburst Site incised with a "sunburst" pattern is clearly an incised split drilled *Olivella* bead with a previously under-recognized incision pattern (Chester King and Robert Gibson, personal communication 2011). According to Milliken and Schwitalla (2012), these bead types are typically diagnostic of two separate periods of time in the Great Basin and San Francisco Bay areas, first during the early Middle Period (210 BC – AD 420) and again during the Middle/Late Period Transition (AD 1010-1210) (see also Bennyhoff and Hughes 1987). Although cultural period designations for Central California do not correspond in time to cultural periods in the Santa Barbara Channel sequence, the radiocarbon dates indicate that this incised split drilled bead type persisted slightly later in time on the islands, likely between AD 1260-1440, and corresponding with the Middle/Late Transition and Late Periods on the islands.

At least one additional example of this bead type with a similar sunburst incision pattern was identified from Santa Rosa Island at Cemetery B at Skull Gulch (SRI-2), dated to the island Transitional and Late Periods. Phil Orr (1968) tested this site extensively using methods that would be considered crude today, but he obtained a $^{14}C$ date from red maids seeds associated with burial 13 at Cemetery B, calibrated to AD 1280-1430. In 2007, Rick obtained another date from the red maids seeds associated with the burial, calibrated to AD

1220-1380 (Rick 2007:249), corresponding well with Orr's initial date and the age of deposits at the Sunburst site. Therefore, the description of the C2i bead type should be modified to include the examples from the Channel Islands, with specific changes made to the description of the incision patterns as well as the temporal interval of occurrence.

## Faunal Remains

*Shellfish*

The majority of shellfish remains observed at Sunburst consist of California mussel and acorn barnacle, as was the case at the other two sites. Quantities of shellfish remains in terms of density per liter are presented here, using the heavy fraction portion of the column sample taken from the sidewall of unit 2, a total of 15.25 liters. Table 5.11 presents the densities of each taxon (grams per liter), as well as the relative proportion (percent) of each. California mussel comprises the vast majority of the shellfish taxa by weight (~93.79%), while acorn barnacle is the second most common taxon (~5.38%). All other shellfish taxa make up the remaining 0.83% of total shellfish.

Table 5.11. Density of Shellfish Taxa at Sunburst, 1/16-inch Column Sample

| | | Stratum 1 | | Stratum 2 | | Total | |
|---|---|---|---|---|---|---|---|
| **Common Name** | **Genus/Family** | **g/L** | **%** | **g/L** | **%** | **g/L** | **%** |
| California mussel | *Mytilus* | 261.5 | 95.87 | 169.6 | 90.77 | 431.13 | 93.79 |
| Acorn Barnacle | *Balanus* | 9.55 | 3.5 | 15.2 | 8.134 | 24.75 | 5.38 |
| Pismo Clam | *Tivela* | 0.15 | 0.06 | 0.16 | 0.083 | 0.31 | 0.067 |
| Gooseneck Barnacle | *Pollicipes* | 0.54 | 0.2 | 0.64 | 0.344 | 1.18 | 0.25 |
| Chiton | Polyplacophora | 0.05 | 0.02 | 0.05 | 0.024 | 0.1 | 0.02 |
| Olivella | *Callyanax* | 0.9 | 0.33 | 1.01 | 0.54 | 1.91 | 0.42 |
| Abalone | *Haliotis* | 0.03 | 0.01 | -- | -- | .03 | <0.01 |
| Limpet | Orthogastropoda | 0.05 | 0.02 | -- | -- | .05 | 0.01 |
| Cockle | Cardiidae | -- | -- | 0.17 | 0.09 | .17 | 0.04 |
| Platform Mussel | *Septifer* | -- | -- | 0.01 | 0.005 | .01 | <0.01 |
| Urchin | *Strongylocentrotus* | -- | -- | 0.02 | 0.012 | .02 | <0.01 |

The shellfish diversity at this site is low, with California mussel dominating the assemblage. Both the chiton and the limpets recovered are very small and may have come the site fortuitously. Several of the limpets appear to be *Lottia insessa*, which typically live on seaweeds and sea grasses, suggesting that seaweeds and/or sea grasses were transported to this site (Ainis et al. 2014). The shellfish assemblage from the Sunburst site looks very similar to CA-SCRI-758, a site dating between 6250 and 3550 cal B.P. and located 600 meters to the south-southwest (Michael Glassow, personal communication 2015).

*Bone*

A summary of the bone recovered from the 1/8-inch screened excavation units is expressed as relative proportion (ratio) of shellfish (g) to bone (g) weight for each stratum (Table 5.12). Bone was sorted to class only, including mammal, bird and fish. The majority of the mammal bone recovered from unit 2 is sea mammal, although a few pieces of possible deer bone were noted during excavation of unit 1. The shell to bone ratios at the Sunburst site are variable, yet they indicate the importance of shellfish in all three strata.

Table 5.12. Sunburst Bone and Shell Weight (g) Ratios, Unit 2

| Stratum | Shell (g) | Mammal (g) | Bird (g) | Fish (g) | Shell:Bone |
|---|---|---|---|---|---|
| 1 | 1300 | 0.29 | 0.12 | -- | 3171:1 |
| 2 | 6450 | 10.59 | 0.15 | 1.92 | 509:1 |
| 3 | 750 | 1.44 | -- | 0.07 | 497:1 |

Small fish bone is better represented in the heavy fraction column samples, which also includes data from the 1/16-inch mesh size, compared with the unit material that includes only remains that are larger than 1/8-inch. Table 5.13 and Figure 5.15 present the densities of bone recovered from 1/16-inch mesh and larger in the heavy fraction portion of

the column samples. Bird bone was not identified in the column samples, despite the large proportion found in unit 2 stratum 1. However, the fish bone from the column sample supports the larger pattern observed in the unit 2 bone data, where higher densities of fish bone occur in stratum 2 compared with stratum 1.

Table 5.13. Density of Mammal and Fish Bone at Sunburst, 1/16-inch Heavy Fraction Column Sample

| Class | Stratum 1 (g/L) | % | Stratum 2 (g/L) | % | Total g/L | % |
|---|---|---|---|---|---|---|
| Mammal | 0.277 | 91.7 | 0.158 | 61.61 | 0.435 | 77.8 |
| Fish | 0.025 | 8.15 | 0.099 | 38.43 | 0.124 | 22.2 |

The relative proportion of mammal bone (primarily sea mammal) is large compared with fish bone in both the unit and column samples. Although earlier time periods are not represented at this site for comparing change through time in a single location, sea mammal bone recovered from the Diablo Valdez site (see Chapter 6) increases in later deposits. It is possible that the relatively large proportion of the mammal bone at the Sunburst site is part of a larger subsistence pattern in which sea mammals were brought to interior sites more frequently during the Late Period.

**Paleoethnobotanical Remains**

The remains of at least 14 distinct plant taxa were identified among the analyzed paleoethnobotanical samples from the Sunburst Site. While the main discussion of the paleoethnobotanical remains is based on those recovered through flotation of the column samples, they were also recovered in the 1/8-inch screened material. These remains include

wood charcoal, brodiaea corm fragments, manzanita berry pits, wild cucumber, and an unidentified tissue that may be from a geophyte other than brodiaea (Table 5.14). These taxa are generally large (>1/8-inch) and relatively hardy, able to withstand the screening process, and represent only a small proportion of plant remains recovered at this site compared with those recovered from column samples processed using flotation.

Table 5.14. Sunburst Botanical Remains from Unit 2, 1/8-inch Screened Material

| Stratum | Wood Charcoal (g) | Brodiaea (g) | Manzanita (g) | Wild Cucumber (g) | UnID Tissue (g) |
|---|---|---|---|---|---|
| 1 | 0.01 | -- | -- | -- | -- |
| 2 | 0.1 | 0.09 | -- | 0.02 | <0.01 |
| 3 | 0.1 | 0.04 | 0.02 | 0.06 | 0.06 |

*Light Fraction Column Samples*

The majority of carbonized botanical remains were recovered in the light fraction portion of the column samples (volume of 15.25 liters). Table 5.15 presents the density per liter for each stratum of all archaeobotanical remains recovered from the light fraction (see Appendix B for raw data). Overall, the archaeobotanical assemblage suggests the use of locally available plant foods, including manzanita berry pits, brodiaea corms, a small amount of acorn, and a few small seeds. These taxa are largely reflective of the habitat types near the site today, including open grassland, chaparral, and oak woodland. A discussion of the ethnographic uses of these plant remains, further analysis, and significance of these plant remains is provided in Chapter 7. This site was occupied for a relatively short period, but its collections provide valuable information on plant food use patterns in the interior during the Middle/Late Transition and Late Periods.

Table 5.15. Density of Archaeobotanical Remains at Sunburst

| **Unit** | | | **CS2** | **CS2** | **CS2** |
|---|---|---|---|---|---|
| **Stratum** | | | **1** | **2** | **2/*** |
| **Depth in cm** | | | **3-12 cm** | **12-22 cm** | **22-39 cm** |
| **Volume (liters)** | | | **3.25** | **5.00** | **7.00** |
| **Time Period** | | **/L** | **Transitional-Late Period** | | |
| Taxon of Large Taxa | Common Name | | | | |
| *Arctostaphylos* spp. | Manzanita | n | 1.23 | 0.2 | 0.22 |
| | | g | 0.003 | 0.001 | 0.001 |
| *Brodiaea* s.l. | Brodiaea | n | -- | 0.6 | -- |
| | | g | -- | 0.002 | -- |
| *Marah* sp. | Wild Cucumber | n | 1.54 | 2.8 | 0.22 |
| | | g | 0.01 | 0.01 | 0.001 |
| *Quercus* spp. | Acorn | n | -- | 0.6 | -- |
| | | g | -- | 0.001 | -- |
| Wood Charcoal (2.0mm) | | g | 0.03 | 0.12 | 0.012 |
| Taxon of Small Taxa | Common Name | | | | |
| *Atriplex* spp. | Saltbush | n | -- | 0.2 | -- |
| *Claytonia* spp. | Miner's Lettuce | n | -- | 0.2 | -- |
| *Hypericum* spp. | Tinker's Penny | n | -- | 0.2 | -- |
| *Madia* spp. | Tarweed | n | -- | 0.4 | -- |
| *Phacelia* spp. | Phacelia | n | -- | 0.2 | 0.22 |
| *Rhus integrifolia* | Lemonade Berry | n | -- | 0.6 | 0.22 |
| *Salvia* spp. | Chia, Sage | n | -- | 1.8 | -- |
| *Trifolium* spp. | Clover | n | -- | -- | 0.62 |
| Asteraceae | Sunflower Family | n | -- | 0.4 | -- |
| Poaceae | Grass Family | n | -- | 0.4 | -- |
| Unidentified Seeds | | n | 4.92 | 0.8 | -- |
| Unidentified Seed Fragments | | n | 11.08 | 5.6 | 0.8 |
| Total Identified to Genus | | n | -- | 3.6 | 1.06 |
| Total Identified to Family | | n | -- | 0.8 | -- |

* Large taxa include values for count and weight, small taxa by counts alone.

*Heavy Fraction Column Samples*

Small amounts of botanical remains were also recovered from the heavy fraction portion of the column samples, presented in Table 5.16 as the density (g/L) for each taxon for each stratum. Paleoethnobotanical remains recovered from the heavy fraction of the column samples include remains that tend to be too heavy to float or are easily water-logged during the flotation process. The relatively low density and diversity of remains recovered in the heavy fraction highlights the effectiveness of using flotation for recovering archaeobotanical remains. In general, the taxa recovered in the heavy fraction are also well represented in both the unit data and the light fraction samples. No taxa were recovered from the heavy fraction that are not represented in the light fraction data, other than unidentified plant tissue.

Table 5.16. Density of Heavy Fraction Archaeobotanical Remains

| Stratum | Taxon | Density |
|---|---|---|
| 1 | UnID Tissue | .043 |
| 2 | Wood Charcoal | .08 |
| 2 | Wild Cucumber | .026 |
| 2 | UnID Tissue | .022 |

*Summary*

The Brodiaea Ridge and Sunburst sites provide valuable information about the use of Santa Cruz Island's interior during various time periods. Both sites are relatively shallow and small in size, especially compared with the upland village site at Diablo Valdez. Although the mixed site deposits at Brodiaea Ridge obscure temporal patterns, the artifact, faunal, and floral assemblages show that people repeatedly inhabited this location during the Early, Middle, and Late Periods. While the artifacts are typical of island sites, bead manufacturing activities appear to have been focused on Pismo clam beads rather than olivella, indicating

procurement of Pismo clams most likely from the Christy Beach vicinity to the west. Marine food resources were imported to the site as well, including California mussels, acorn barnacles, sea mammals, fish, and birds. Importing marine resources to this interior location suggests that terrestrial plant resources may have been a motivating factor in settlement location. Indeed, plant remains are relatively well represented at this site.

The Sunburst site was occupied for a much shorter period of time during the Middle-Late Transition and Late Periods. Rather than a residential base, Sunburst appears to have been a short term/seasonal logistical encampment presumably for the procurement of plant resources and fresh water, but where olivella bead manufacturing also took place. Some Pismo clam bead detritus was also found, although in much smaller quantities than olivella detritus. Other marine resources were transported to the site, including shellfish, sea mammal, bird, and fish. Seaweeds or seagrasses also appears to have been brought to the site based on the presence of small limpets. Plant remains are also present at this site, and are discussed in more detail in Chapter 7. The small interior Sunburst site demonstrates that the Islanders were using the interior during and just after the MCA and participating in the larger olivella bead manufacturing economy away from the coast.

# CHAPTER 6

# DIABLO VALDEZ: AN UPLAND VILLAGE SITE

The Diablo Valdez site is situated at an upland location on the north side of the island at approximately 1500 foot elevation, 1 km northwest of Diablo Peak and 1.8 km from the north coast. This area of the island is characterized by steep slopes and deep, well watered canyons. High, sheer cliffs along the northern coast are prevalent, although there are several sections in the vicinity where coastal access is possible, particularly towards Cueva Valdez to the west and near Lady's Harbor to the east of the ridge on which the Diablo Valdez site is situated. Vegetation communities in this area include open grasslands along the ridge tops punctuated by bedrock outcrops and abundant oaks, islay, ironwood, and cottonwood trees in the canyons and hillsides. Grasslands contain a variety of plant foods, including abundant geophytes and small seeds in addition to the scattered Santa Cruz Island buckwheat, prickly pear cactus, and lemonade berry bushes. Manzanita is also present on these slopes, particularly at higher elevations. Overall, the vegetation communities in the vicinity of Diablo Valdez would have provided people with abundant plant foods, fuels, medicines, and tools.

Generally, the deep canyons immediately to the east and west of the site contain more water lower down and closer to the coastline, yet access to these sources may have been more difficult due to steep slopes. However, the bedrock in the canyon bottom immediately southeast of Diablo Valdez collects water in large pools from a series of seeps and springs that begin in the upper reaches of the canyon. These pools contain water year-round, including during the summer of 2014, after three years of severe drought.

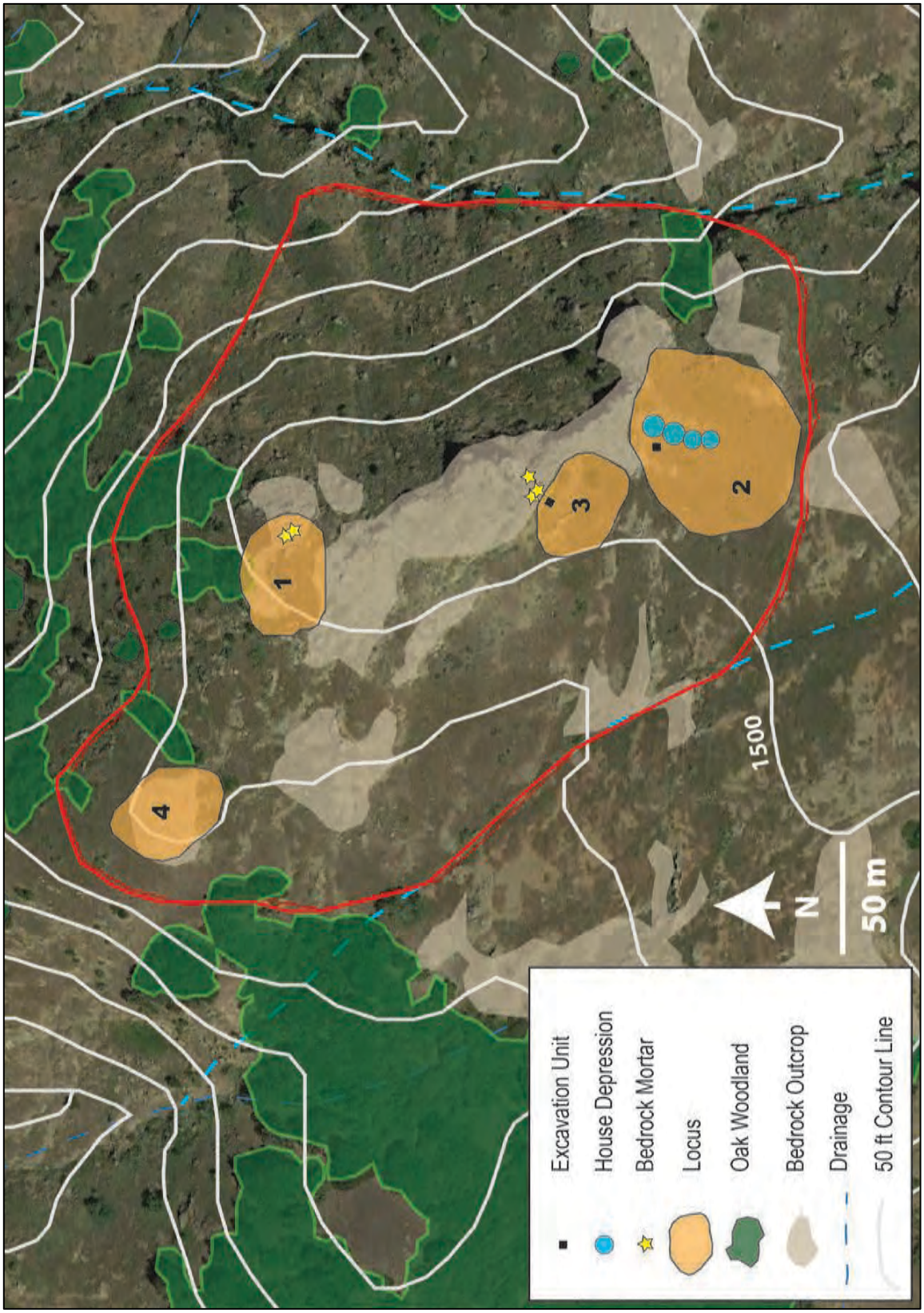


Figure 6.1. Sketch Map of Diablo Valdez (CA-SCRI-619/620)

Furthermore, the contribution of fog water to the island's hydrology at this location may have been significant, especially during the summertime when dense coastal fog is pushed up against the northern slopes by prevailing winds.

A map of the Diablo Valdez site is shown in Figure 6.1. The north-south trending ridgeline on which the site occurs is fairly narrow in places, with steep slopes leading to the drainages to the east, and west. However, the ridge in the vicinity of the site is broader, with relatively gentle slopes toward the west compared to elsewhere along the ridge. The site boundaries (shown in red in Figure 6.1) are extensive (approximately 320 m north-south by 280 m east-west) and include all areas containing cultural material. Because of the steepness

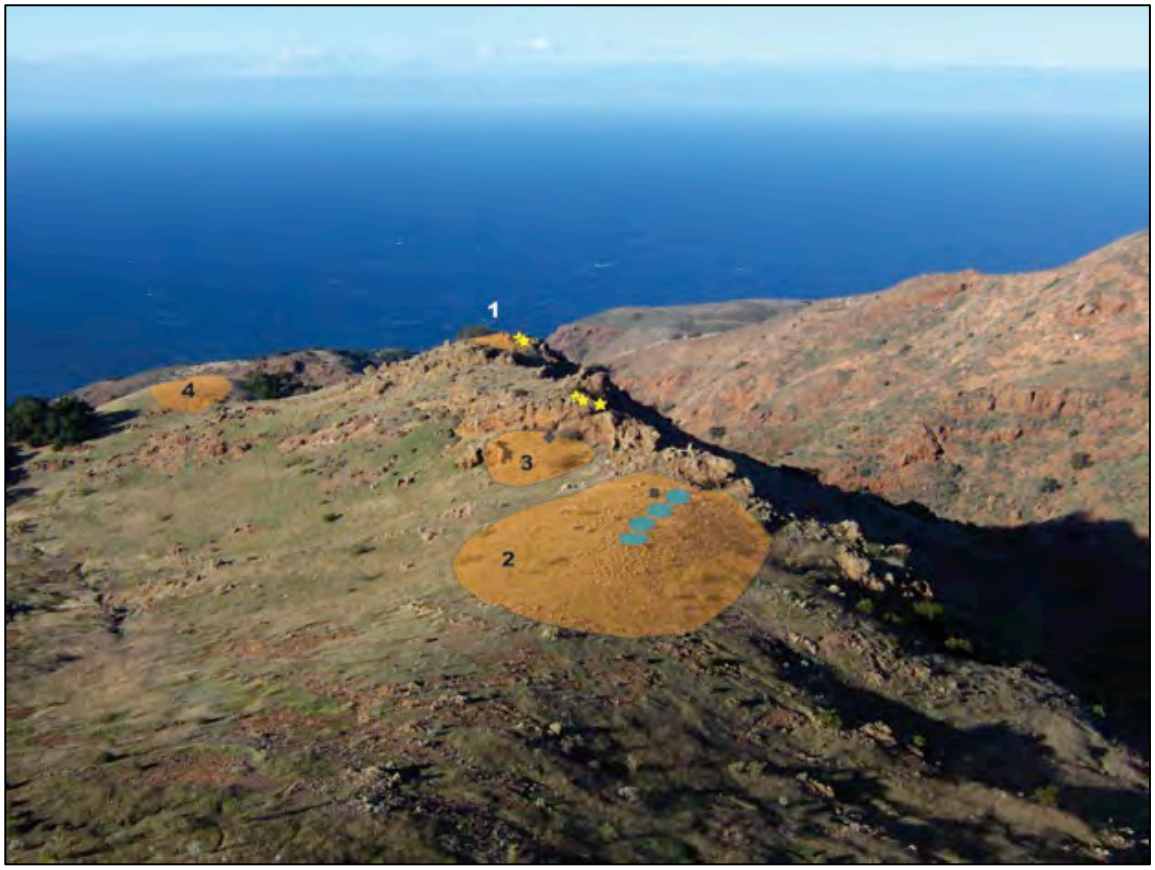


Figure 6.2. Oblique Aerial View of the Diablo Valdez Site, Facing North (photo by K. Gill).

of the slopes on either side of the ridgeline, shellfish remains and artifacts were documented all the way to the base of the canyons on either side of the ridge. The majority of intact deposits occur close to the bedrock outcrop along the top of the ridge, yet cultural remains are present throughout and in varying densities. Four loci were identified as containing higher concentrations of shellfish and artifacts compared with surrounding areas (see Chapter 4). As discussed in detail below, loci 2 and 3 contain the highest concentrations of shellfish and were the most extensively tested. An oblique aerial photograph of the Diablo Valdez site shown in Figure 6.2 provides a better perspective of the topography of the ridge and surrounding features on the landscape. The loci, bedrock mortar and house depression locations indicated also appear on the site map (Figure 6.1).

**Bedrock Mortars and Surface Collection of Artifacts**

While bedrock mortars are relatively rare on the islands, the Diablo Valdez site contains five: two at locus 1, and three on the outcrop above locus 3 (see Figure 6.1). Overall, these mortars are large, deep, and therefore fairly conspicuous in the heavily eroded volcanic bedrock (Table 6.1). It is possible that additional mortars occur in these outcrops but have been too heavily eroded to be confidently identified. Nevertheless, the five bedrock mortars identified at Diablo Valdez are unusual, as the majority of other known sites that contain bedrock mortars typically have only one. However, portable bowl mortars are fairly common at sites across all the islands and represent essentially the same type of processing technology. Figure 6.3 shows the two deepest bedrock mortars located on the rock outcrop above locus 3, as well as the extent of weathering typical of these mortars.

Table 6.1. Measurements of the Diablo Valdez Bedrock Mortars

| Locus | Diameter | Depth |
|---|---|---|
| 1 | 19 cm | 16 cm |
| 1 | 16 cm | 14 cm |
| 3 | 20 cm | 17 cm |
| 3 | 21 cm | 31 cm |
| 3 | 17 cm | 32 cm |

Figure 6.3. Two Deep Bedrock Mortars Located in the Bedrock Outcrop above Locus 3 (photo by K. Gill).

As discussed in Chapter 4, a variety of artifacts were collected from the surface of the site. Many of the surface artifacts were found on or near the base of the slope to the west of loci 2 and 3. Numerous portable bowl mortar fragments, made of a variety of materials, were

the most prominent type of groundstone items collected. A sample of these bowl fragments is pictured in Figure 6.4, including a) a dark gray fine-grained volcanic bowl fragment finely pecked on the exterior surface; b) a coarse-grained conglomerate bowl fragment that may be fire affected; c) a pinkish coarse-grained volcanic bowl rim fragment with pecking evident on exterior surface; d) a brown sandstone bowl rim fragment containing both coarse and fine grain sand constituents.

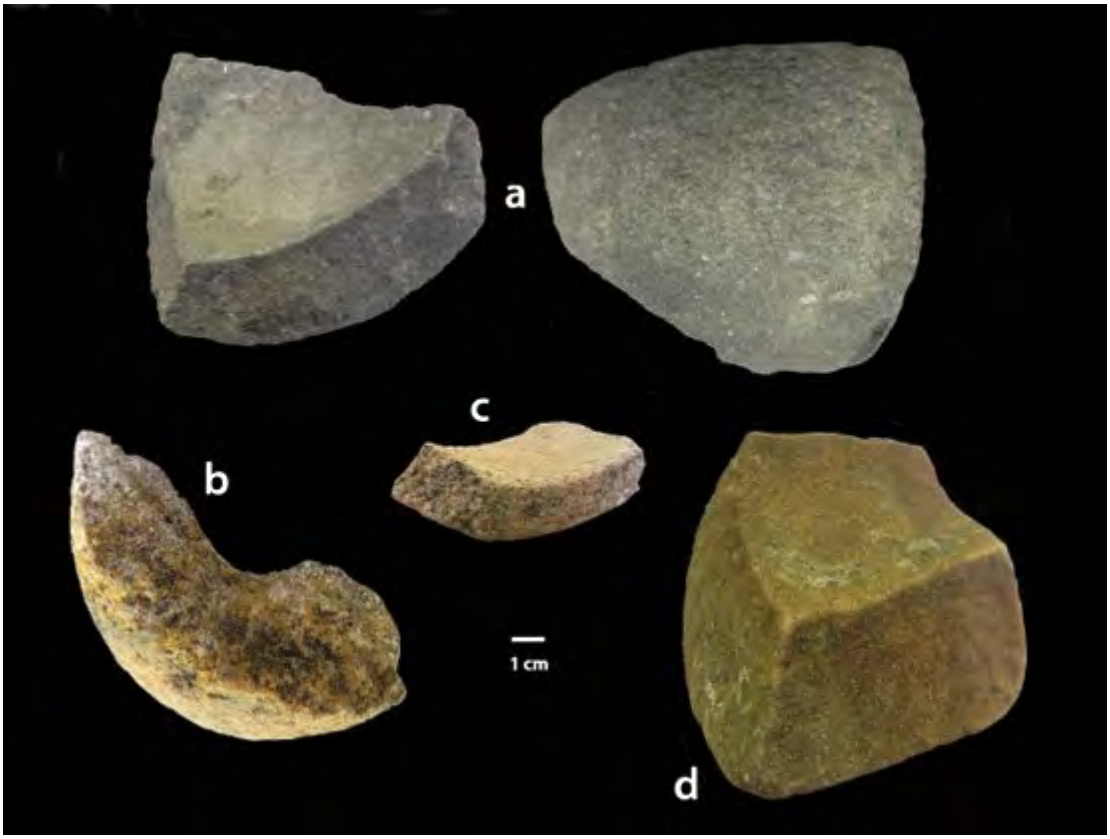


Figure 6.4. Bowl Mortar Fragments Surface Collected at Diablo Valdez (photo by K. Gill).

Several reamers/pecking tools were also identified on the surface, made of Santa Cruz Island chert and volcanics (Figure 6.5). The large SCRI chert reamer/pecking tool (Figure 6.5a) has use-wear on the sides and the tip, suggesting it was used as both a reamer and

pecking tool. Due to its large size and use-wear patterns, it is possible that this artifact was used to manufacture/drill digging stick weights. The small SCRI chert reamer (Figure 6.5b) has use-wear on the sides, but the tip is broken off. The trifacial metavolcanic pecking tool (Figure 6.5c) has minimal use-wear on the tip, and no use-wear on the sides. This artifact may have been used for pecking rather than reaming, although it shows only minimal use-wear. Prior to being trifacially worked, it was used as a hammerstone. These artifact types have been identified at various island sites, all exhibiting little to no use-wear, yet strongly correlated with sites that also contain groundstone (Conlee 2000; Perry 2003:166). These artifacts have been suggested as tools used in stone bowl manufacture and/or maintenance

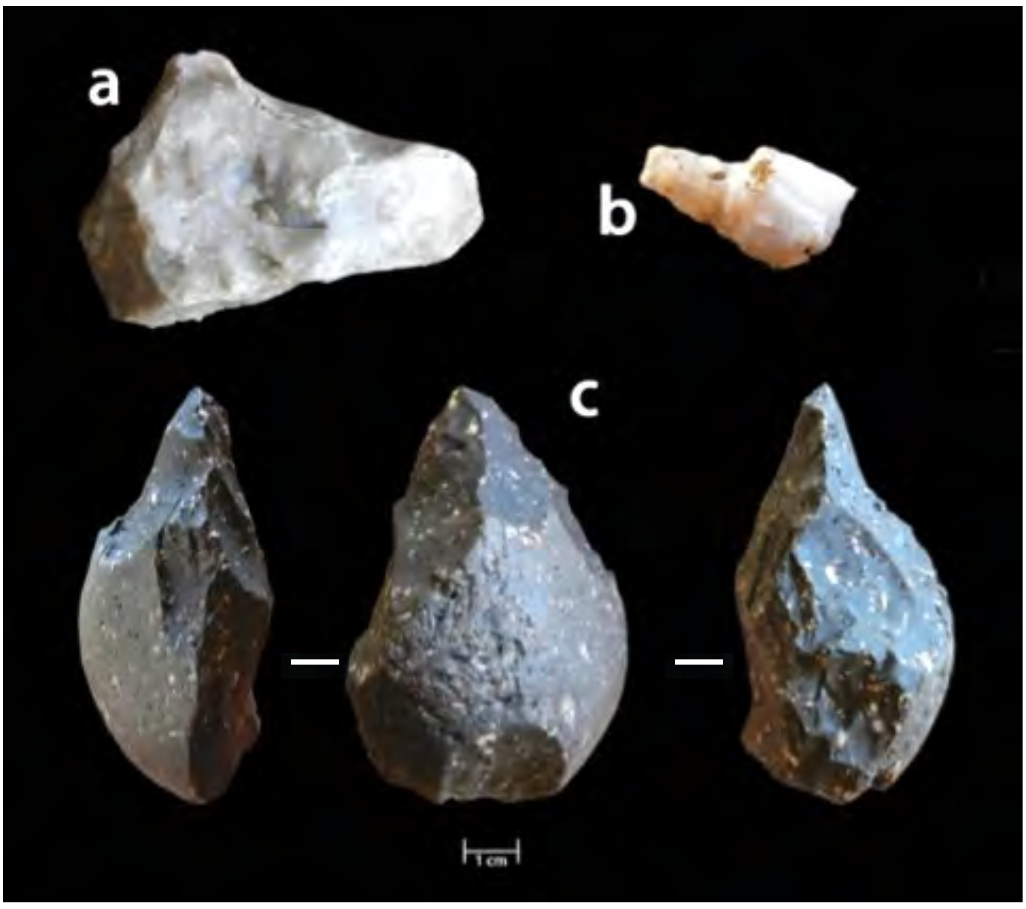


Figure 6.5. Reamer/Pecker Technology Collected from the Surface at Diablo Valdez

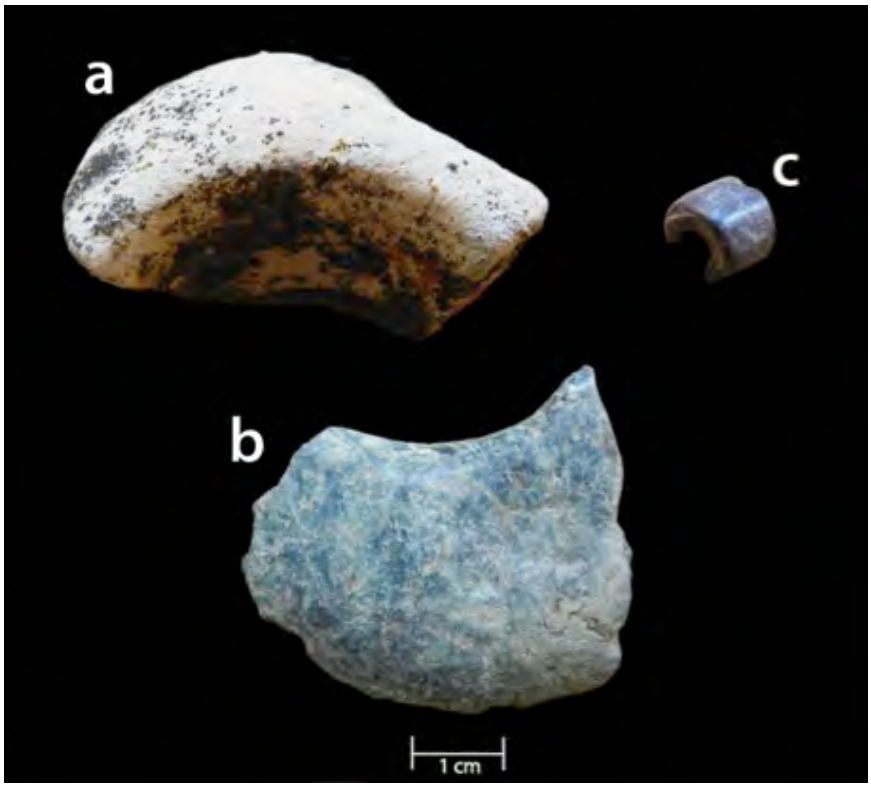


Figure 6.6. Doughnut Stones and Steatite Bead Surface Collected at Diablo Valdez; a) Monterey Shale Doughnut Stone Fragment; b) Serpentine Doughnut Stone Fragment; c) Serpentine Bead (Photo by K. Gill).

(Conlee 2000; Hudson and Blackburn 1986:37-39), an activity that may have occurred at the Diablo Valdez site as well, at least to some extent. While the lack of use-wear is puzzling, several of Harrington's consultants described using pecking tools with a sharp point in the manufacture and maintenance of groundstone (Hudson and Backburn 1986:37-39).

Two digging stick weight (doughnut stone) fragments were also found on the surface, as well as a broken serpentine bead (Figure 6.6). The white doughnut stone fragment (Figure 6.6a) is made of Monterey shale or some other type of fine-grained material.
Given the abundance of Monterey shale available near Cueva Valdez, it is possible that this material came from a local source. The green doughnut stone fragment is serpentine (Figure 6.6b), and the broken cylindrical bead is also serpentine but darker in color (Figure 6.6c).

Both lighter and darker varieties occur in the Santa Barbara County backcountry and were traded to the island from the mainland.

Finally, formal chipped stone artifacts were collected, including several projectile points and a biface preform (Figure 6.7). Several other bifaces were also collected but are not pictured here. Figure 6.7a is a blond SCRI chert contracting stem point, typical of Late period knife blades and dart or harpoon points. One end of the point (top) has a significant amount of abrasion, perhaps from use as a hafted rasp. It is unclear what material was being rasped using this point, but the abraded surfaces are very smooth, with no obvious microwear pattern present. The Chumash used hafted chert rasps (used like a file) for roughly shaping

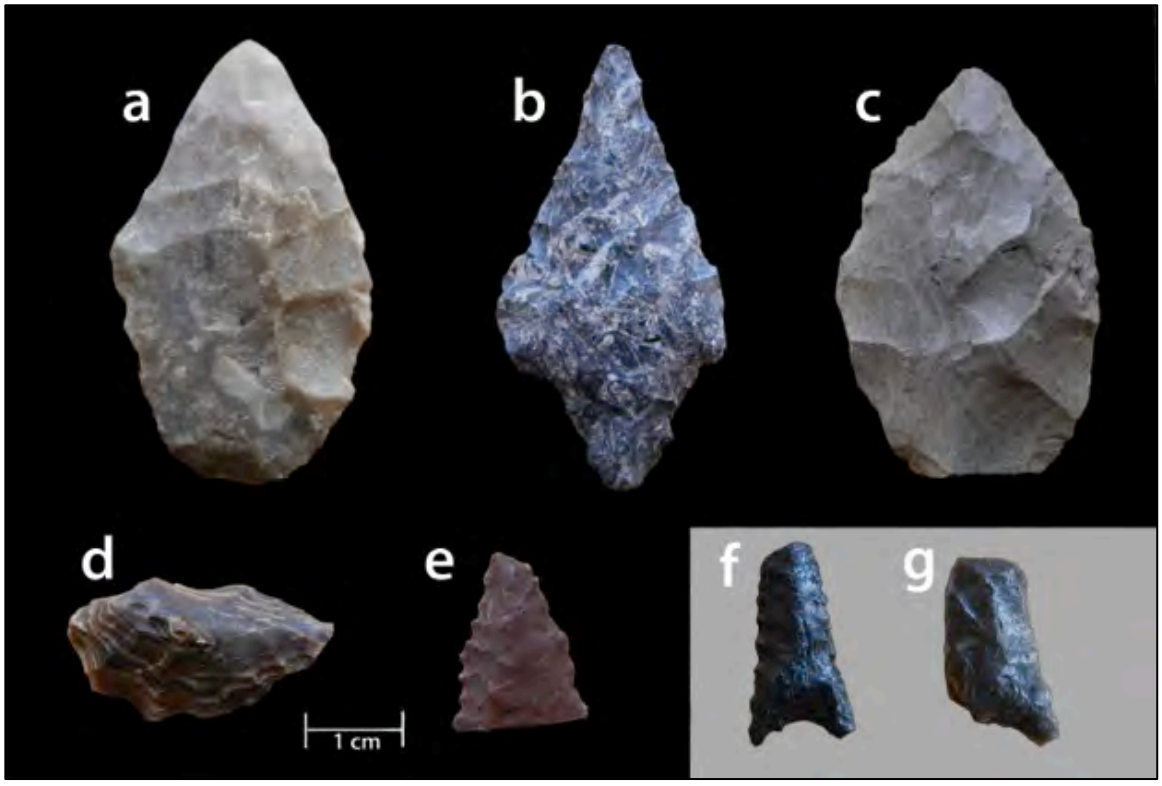


Figure 6.7. Surface Collection; a) SCRI Chert Projectile Point with Heavily Ground End; b) SCRI Chert (mottled black and white) Projectile Point; c) Heat Treated Siliceous Shale Projectile Point; d) Monterey Chert Biface Preform; e) Franciscan Chert Projectile Point Fragment; f) Fused Shale Projectile Point; g) Fused Shale Projectile Point (photo by K. Gill).

wood or cutting shell. According to Fernando Librado, "Indians used to cut abalone shells with flint. Patient women would cut off the shoulders of the shell below the holes [abalone] and would use the shell for pendants to hang on breast and give the men the shoulder for a fishhook" (Hudson and Blackburn 1986:122). Another Harrington consultant said that some shell utensils (e.g., abalone shell drinking cup) were rasped to "make it look pretty" (Hudson and Blackburn 1986:122). As described below, a piece of incised abalone was recovered in Late Period deposits at locus 2, and may have been incised using a similarly hafted rasp.

Figure 6.7b is a contracting stem projectile point made of SCRI chert, yet is uniquely mottled black and white in color. This black and white mottled SCRI chert is described in more detail below, as this material was identified in both debitage and microdrill assemblages. The leaf shaped point (Figure 6.7c) is a heat affected siliceous shale that is almost chert-like. Figure 6.7d is a banded Monterey chert biface preform, and (e) is a broken, slightly serrated red Franciscan chert point tip. Figure 6.7f and (g) are both bases of small Cottonwood Triangular fused shale points, typical of Late Period assemblages. Both the Franciscan chert and fused shale specimens are exotic rock types almost certainly obtained via trade with the mainland.

**Soils, Stratigraphy and Site Structure**

*Locus 1 – The Overlook*

Locus 1 is situated at the northern extent of the bedrock outcrop, just before the slope descends steeply northward toward the coast. The presence of a human burial encountered near the center of the midden during initial ECS testing precluded further investigation at this location. Because no larger unit excavations were conducted at locus 1, the soils, stratigraphy

Figure 6.8 – K. Gill and D. McKenzie at Locus 1 (ECS 1), Facing North, with Views of the Santa Barbara Channel and Mainland (Point Conception is visible on the left) (photo by T. Joslin).

and site structure are not well documented. However, the ECSs revealed a dark, silty, moderate to high density midden extending to at least 15 cm below surface in the eastern sector, and around 40 cm below surface on the western edge. The main area of the intact midden is approximately 20 m wide (east-west) and 25 m long (north-south), not including the bedrock mortars or midden occurring on the slopes to the west, north and east. Figure 6.8 shows the extent of the intact midden on its western and northern margins, with a view of the Santa Barbara Channel beyond.

*Locus 2 – The Saddle*

Locus 2 is situated in a shallow saddle on the southern side of the rock outcrop, before the slope rises again steeply towards the main ridgeline to the south. The area is relatively flat, with slight mounding towards the center of the locus, suggesting that deposits may be deep in this area. Four house depressions occur in a north-south orientation on the leeward side, but no other features are visible on the surface. The tall rock outcrops to the north of locus 2 obscure the extensive view of the Santa Barbara Channel to the north, but also largely protect the area from the prevailing northwesterly winds. Excavation units at locus 2 were placed west of the visible house depressions on the surface, on the flattest

Figure 6.9. M. Glassow (right), H. Chodsky and C. Jazwa at Locus 2, Facing Southwest Towards the Ridgeline of the Northern Range (photo by K. Gill).

portion of the northern side of the locus near bedrock. Ultimately, excavation revealed that this location did have substantial depth (>2m), and numerous domestic features, including a structural floor, were encountered during excavation, suggesting that the site served as an important residential base long before the time of the surface house depressions.

The deposits at locus 2 extend over an area of about 60 m (north-south) and 65 m (east-west), comprised of a series of complex and well-defined cultural strata over two meters deep in places and sitting directly on top of bedrock. A summary of the site stratification is provided in Table 6.2, including brief descriptions of each stratum identified in the soil profile. Figure 6.10 presents the soil profile drawings of the west wall of unit 2, with color shading based on the Munsell (dry) soil color chart. Thirty-two discrete strata and substrata were identified in unit 2, representing a long and complex record of human occupation and cultural activities spanning nearly 6,000 years. A series of well-preserved domestic features were also encountered during excavation, and are described in more detail below.

Table 6.2. Summary of Soils and Stratigraphy at Diablo Valdez, Locus 2, Unit 2, West Wall

| Stratum | Munsell (dry) | Description |
|---|---|---|
| 1A | 7.5 YR 2.5/1 | Black; Silty; Medium density shellfish; Dense, loose deposits w/ charcoal |
| 1B | 7.5 YR 2.5/1 | Black; Silty; Similar to 1A with slight increase in shellfish density |
| 2A | 10 YR 5/1 | Pit Feature; Gray; Very fine ash; Pit Fill with shell, bone, charcoal; Friable |
| 2B | 10 YR 4/1 | Pit Feature; Dark Gray; Very fine ash; Pit Fill; Friable |
| 2C | 7.5 YR 7/1 | Pit Feature; Light gray; Very fine ash; Pit Fill; Friable |
| 2D | 10 YR 5/2 | Grayish brown; Very fine ash; Compact |
| 2E | 10 YR 6/2 | Light brownish gray; Very fine ash; Compact |
| 2F | 10 YR 4/1 | Dark gray; Silty; High density shellfish; Compact |
| 2G | 10 YR 3/1 | Very dark gray; Silty; Low density shellfish; Compact |
| 2H | 10 YR 6/2 | Edge of Structure, with imported fill; Light brownish gray; Very fine ash |
| 3A | 10 YR 4/1 | Dark gray; Silty; High density shellfish |
| 3B | 10 YR 4/1 | Dark gray; Decreased shellfish density from 3A |
| 3C | 10 YR 4/1 | Dark gray; High density shellfish |
| 3D | 10 YR 4/1 | Dark gray; Decreased density shellfish from 3C |
| 3E | 10 YR 4/2 | Dark grayish brown; High density shellfish, highly fragmented |
| 3F | 10 YR 5/1 | Post Hole; Gray; Silty; Medium density shellfish; Very compact |
| 3G | 10 YR 5/1 | Post Hole; Gray; Silty; Medium density shellfish; Very compact |
| 3H | 7.5 YR 4/1 | Post Hole; Dark gray; Silty; Very compact |
| 3I | 10 YR 4/2 | Dark grayish brown; Silty; High density shellfish; Very friable |
| 3J | 10 YR 4/1 | Dark gray; Silty; High density shellfish |
| 4A | 7.5 YR 4/1 | Dark gray; Silty; Very high density shellfish, primarily large acorn barnacles |
| 4B | 7.5 YR 4/1 | Dark Gray; Silty; Similar to 4A with increased proportion of mussel to barnacle |
| 5 | 10 YR 4/2 | Dark grayish brown; Silty; Very low density shellfish; Very compact |
| 6A | 10 YR 4/2 | Dark grayish brown; Silty; Very high density shellfish; Friable |
| 6B | 10 YR 6/2 | Light brownish gray; Silty; Very high density shellfish; Friable |
| 7 | 10 YR 5/1 | Roasting Pit; Gray; Very fine ash; Mottled white/brown; Very compact patches |
| 8A | 10 YR 3/2 | Very dark grayish brown; Silty; Low density shellfish; Compact |
| 8B | 10 YR 3/2 | Very dark grayish brown; Silty; Medium density shellfish; Friable |
| 9 | 10 YR 6/2 | Possible Roasting Pit; Light brownish gray; Ash |
| 10A | 10 YR 3/2 | Very dark grayish brown; Low density shellfish |
| 10B | 10 YR 3/4 | Dark yellowish brown; Very low density shellfish; Transition to sterile |

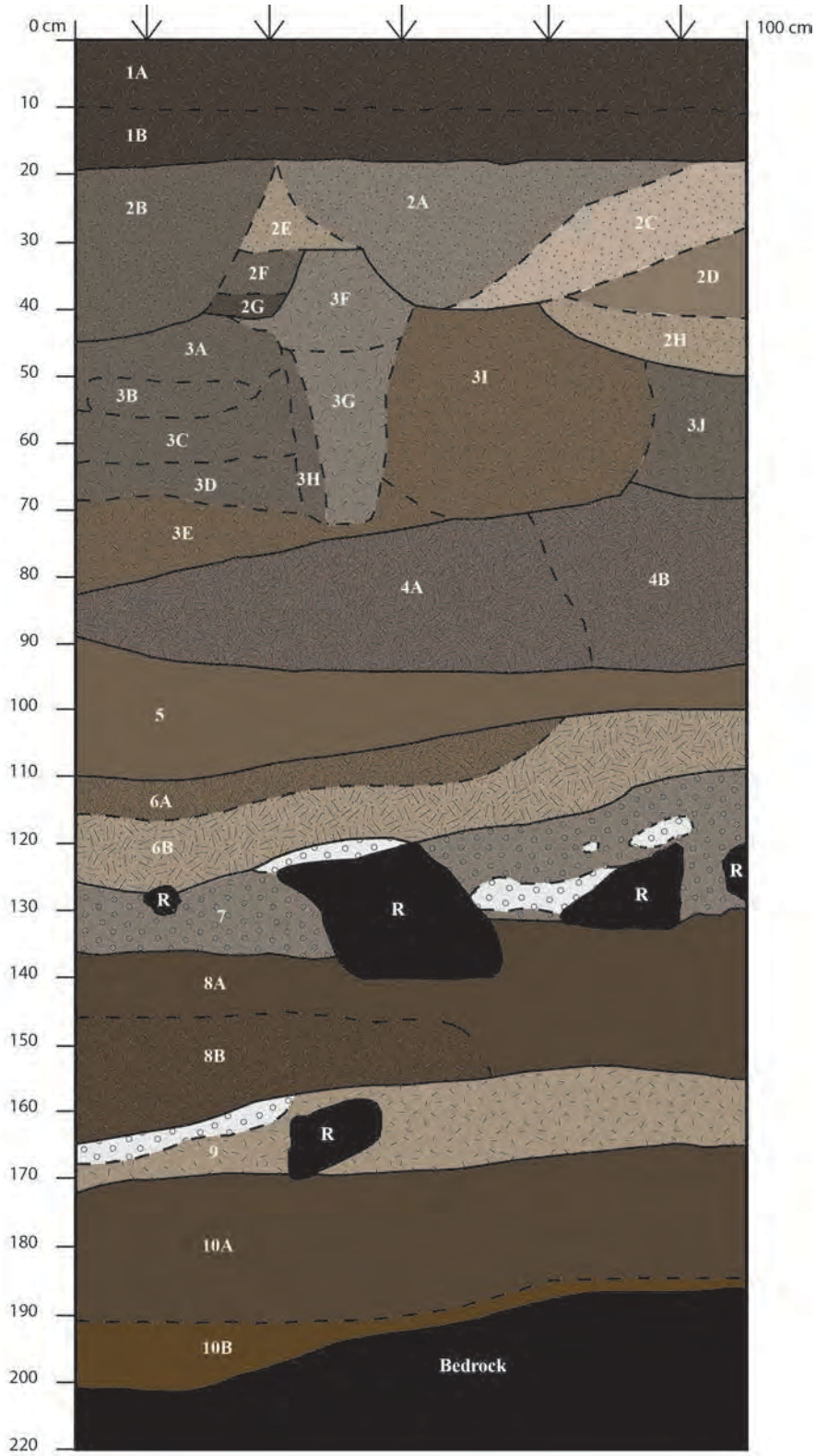


Figure 6.10. Stratigraphic Profile Drawing at Diablo Valdez, Locus 2, Unit 2, West Wall (white lenses indicate mottled white ash deposits).

*Hearth Clearing Pit Features*

A series of pit features (strata 2a-d) that contain large amounts of ash and relatively little shellfish, dug into slightly older deposits (2e-g). These features are evident in the wall profile (Figure 6.10) and were obvious during excavation as well (Figure 6.11). As discussed in more detail below, these pit features are interpreted as hearth cleaning pits,

Figure 6.11. Excavated Hearth Clearing Pit Features at Diablo Valdez, Locus 2 (photo by K. Gill).

Figure 6.12. Reddish Burned Earth (center) Surrounded by Pit Features. Top-Center Pit Contains Light Ashy Deposits (photo by K. Gill).

with abundant plant remains, burned shellfish, beads, and ashy deposits. Although not evident in the sidewall profile, thin areas of burned earth were identified at the top and between the pits, suggesting that the pits were originally dug directly through the burned earth upon which the pit contents may have originated (Figure 6.12).

*Edge of Structure With Imported Fill and Post Holes*

The edge of a structure, floor, and two post-holes (~15 cm diameter) were identified during excavation of unit 2 (Figure 6.13). Only a small section of the surface was easily identified in the profile (stratum 2H), however, as the floor angles northwards at the western wall of the unit and extends beyond the excavation unit to the north. The two post-holes, a section of one identified as strata 3F-H on the profile, also included remnant post-molds evident in Figure 6.13. Although household archaeology has been limited on the Channel

Figure 6.13. Southern Edge of Living Surface (Stratum 2H), Unit 2, Locus 2 of the Diablo Valdez Site, Showing Two Post-holes and Post-molds, facing west.

Islands (although see Orr 1968; E. Sutton 2014), and this structural feature is well preserved, no additional excavation was conducted to further expose this feature. However, the location of the post-holes around the outer edge of the floor is consistent with Chumash and other prehistoric house construction techniques (Gamble 1995; Hudson and Blackburn 1981).

*Roasting Pits*

Two roasting pit features were identified during excavation and are depicted in the sidewall profile as strata 7 and 9. The roasting pit identified as stratum 7 is clearly defined, and the majority of the roasting pit was encapsulated by both excavation units 1 and 2, although the feature is evident in all four sidewalls and continues further to the west and north (Figures 6.14 and 6.15). This roasting pit feature contains large rocks arranged within a

shallowly excavated pit. A thin layer of dark black soil containing large amounts of charcoal occurs underneath and between the base of the rocks, while the deposits above contain dark gray soils, mottled with pockets of very light ash. This ash is particularly compact and abundant along the eastern edge of the feature in unit 1 and continues into the eastern wall (Figure 6.15). The compactness of the ashy deposits may point to repeated use of the same feature, possibly with the ash deposits held together by fats used in or resulting from cooking, or simply by soil moisture.


Figure 6.14. Roasting Pit Feature at Diablo Valdez, Locus 2, Unit 2 (left), Unit 1 (right), Stratum 7, 1 x 1 m (composite of two different photos) (photos by K. Gill).

Figure 6.15. Profile of Roasting Pit Feature Eastern Edge (Stratum 7) (below 1 m mark), Unit 1, Diablo Valdez, Locus 2 (photo by K. Gill).

Stratum 9 is described as a possible roasting pit feature that is much less well defined than the feature in stratum 7. However, the presence of several large rocks, charcoal and mottled compact ash is similar to the deposits seen in stratum 7. Radiocarbon dates for these two strata indicate they were used close to the same time, between 4420 and 4770 years ago (see chronology section below), suggesting that age alone does not account for the poor preservation of the stratum 9 feature (see Table 6.5). Rather, it is more likely that the feature was left exposed to the elements after it was last used prior to being covered with later deposits, whereas the roasting pit at stratum 7 may have been covered relatively quickly after its final use.

*Locus 3 – The Rockshelter*

While locus 2 is situated in an open area in the saddle south of the main bedrock outcrop, locus 3 occurs adjacent to the bedrock outcrop under a slight overhang, creating a shallow rockshelter on the southwestern side of the outcrop (Figure 6.16). This rockshelter affords excellent protection from the prevailing winds that blow through the channel, in addition to providing shade during the morning and early afternoon. The cultural deposits at locus 3 extend from the outcrop walls approximately 10 meters to the west, creating a slight berm in front of the shelter before sloping steeply down towards the swale below.

Figure 6.16. M. Glassow at the Locus 3 Rockshelter at the Diablo Valdez Site, Facing North/Northeast (photo by K. Gill).

The overall site structure at locus 3 is comprised of a series of well-defined cultural strata over 1.5 meters deep, sitting directly on bedrock. Due to the contours of the surface and orientation of the rockshelter face, excavation units were oriented in a northwest/southeast direction, with the northeastern wall aligned with the face of the rockshelter (hereafter the direction toward the rockshelter face is designated "north"). The stratigraphic profile drawing (Figure 6.17) is of the eastern wall profile of unit 1, with color shading based on the Munsell (dry) soil color chart. A summary of the site stratigraphy is provided in Table 6.3, with a brief description of each stratum identified in the profile. Fewer features were identified at locus 3 than at locus 2. One of them was a hearth (stratum 2A) identified in the central and northwestern portions of unit 2 within Middle Period deposits. The most significant feature identified, however, was the edge of an intact, flexed burial encountered at the southwestern edge of unit 2, within Late Period deposits. The burial is oriented with the head facing west, away from the face of the rockshelter. Once the burial was recognized and documented, it was re-buried with unscreened soil, and the southern 1/4 of the unit was abandoned. There was no further disturbance to the burial. No other human remains were encountered at locus 3.

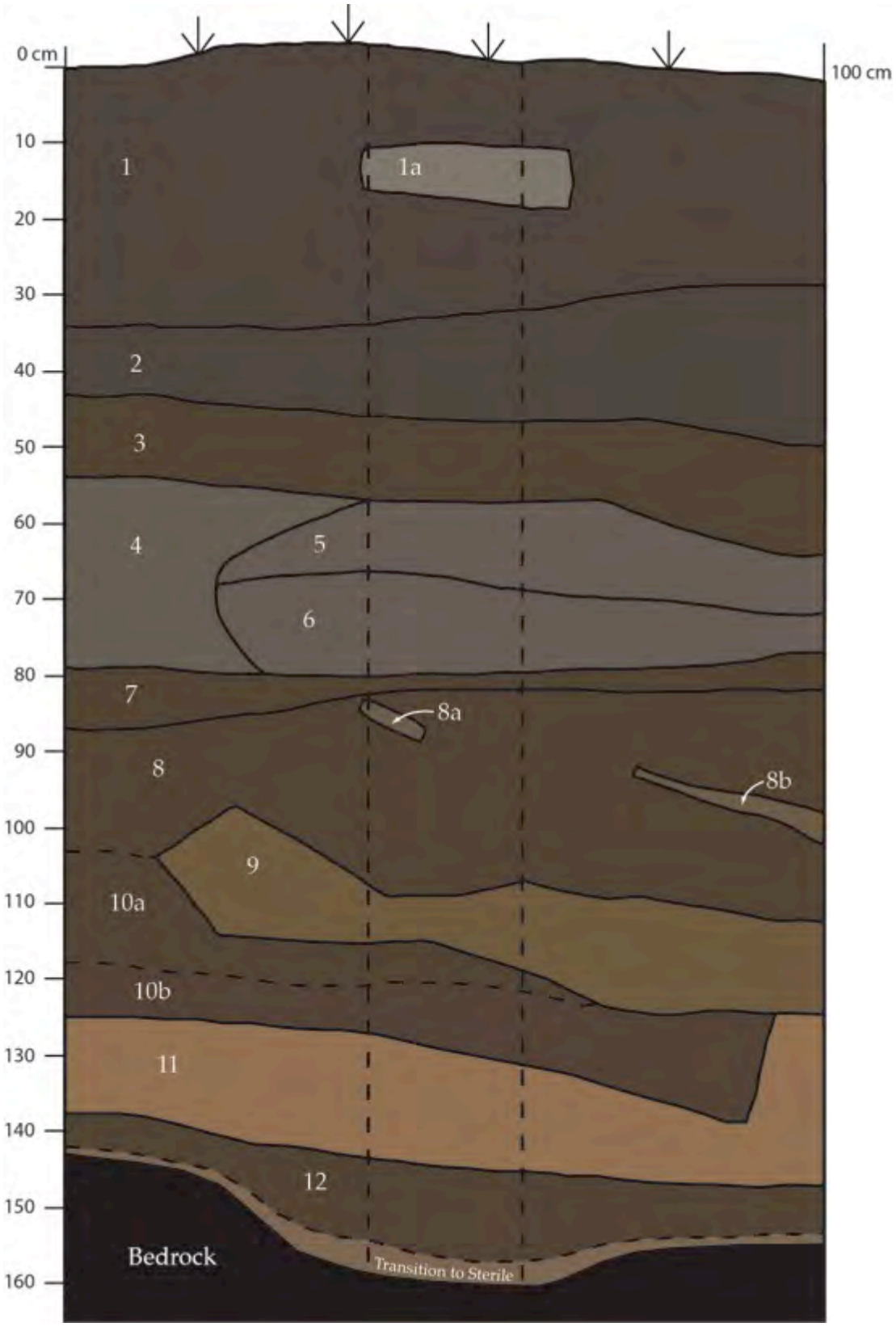


Figure 6.17. Stratigraphic Profile Drawing at Diablo Valdez, Locus 3, Unit 1, East Wall

Table 6.3. Summary of Soils and Stratigraphy at Diablo Valdez, Locus 3, Unit 2

| Stratum | Munsell | Description |
|---|---|---|
| 1 | 7.5 YR 3/1 | Very Dark Gray; Silty; Medium density shellfish |
| 1A | 10 YR 5/1 | Gray; Silty; Medium density shellfish |
| 2 | 7.5 YR 3/1 | Very dark gray; Silty; Increased shellfish density |
| 3 | 10 YR 3/2 | Very dark grayish brown; High density shellfish, whole shells; Friable |
| 4 | 10 YR 4/1 | Dark gray; Silty; High density shellfish |
| 5 | 7.5 YR 4/1 | Dark gray; Silty; Medium density shellfish; Very compact |
| 6 | 7.5 YR 4/1 | Dark gray; Slightly clayey |
| 7 | 10 YR 3/2 | Very dark grayish brown; Silty; Low density shellfish; Very compact |
| 8 | 10 YR 3/2 | Very dark grayish brown; Silty |
| 8B | 10 YR 4/2 | Dark grayish brown; Silty |
| 9 | 10 YR 4/3 | Brown; Silty; High density shellfish, whole or nearly whole; Friable |
| 10A | 10 YR 3/2 | Very dark grayish brown; Silty; Medium density shellfish, fragmented |
| 10B | 7.5 YR 3/2 | Dark brown; Silty; Medium density shellfish, highly fragmented |
| 11 | 7.5 YR 5/4 | Brown; Silty; High density shell, somewhat fragmented |
| 12 | 10 YR 3/2 | Very dark grayish brown; Low density shellfish; Transition to sterile at base |

The majority of the strata at locus 3 consisted of dark gray to grayish brown silty deposits with variable shellfish densities. Strata 9 and 11, both dating to the Early Period, were very distinct from other deposits, appearing lighter brown in color with high shellfish density and a very soft, friable matrix.

**Site Chronology**

The chronology of the Diablo Valdez site is presented by locus, with stratum designations corresponding with the soil profile drawings presented above. As discussed in Chapter 4, 21 $^{14}C$ dates for this site indicate that it was occupied repeatedly over the last 6,000 years. The majority of site deposits date to the Early and Late Periods, with comparatively ephemeral evidence for occupation during the Middle Period, although it does occur. For analytical purposes, Early Period deposits were separated into "Early" and "late

Early" due to the extensive nature of Early Period deposition at loci 2 and 3. The transition from the middle to late Holocene, ca. 3500 years ago, was chosen as the division between the Early and late Early Periods.

*Locus 1 – The Overlook*

A single $^{14}C$ date was obtained from the base of locus 1 deposits, indicating this location was initially occupied during the Late/Protohistoric Period. No further dating was conducted, although it is assumed that all deposits at this location date to the Late Period, as they do not appear mixed and are underlain by bedrock.

Table 6.4 Chronology of Diablo Valdez, Locus 1

| Stratum | Level | Lab # | $^{14}C \pm \sigma$ | Mat. | $\delta^{13}C$ | cal BP Age Range (2σ) | cal BC/AD (2σ) | Cultural Period |
|---|---|---|---|---|---|---|---|---|
| CS3 | 40-43 | Beta-282798 | 590±40 | Mu | -1.5 | 370-540 | AD 1410-1580 | Late/ Protohistoric |

*Locus 2 – The Saddle*

Ten $^{14}C$ dates were obtained from locus 2, presented in Table 6.5. Two initial dates were obtained from single fragments of California mussel shell at both the base and surface of the deposits (Beta-282799 and 332396) during testing at ECS1. The "base" of ECS1 was only 120 cm below surface, where the auger hit an obstruction. This obstruction was likely a stone, and compared with the depth (and radiocarbon date) of the roasting pit feature (stratum 7) encountered during the main excavation, it is plausible that the feature extends one meter to the west where the ECS was located, or that another roasting feature occurs here. The majority of the other $^{14}C$ dates were obtained from single carbonized manzanita berry

Table 6.5. Chronology of Diablo Valdez, Locus 2

| Stratum | Depth (cm) | Feature | Lab # | $^{14}C \pm \sigma$ | Material[1] | $\delta^{13}C$ | cal BP Age Range $(2\sigma)^2$ | cal BC/AD $(2\sigma)^2$ | Cultural Period |
|---|---|---|---|---|---|---|---|---|---|
| ECS1 | 0-10 | | Beta-282799 | 3260±40 | M | -3.4 | 3220-3470 | 990-760 BC | Late Early |
| 2B | 23-30 | Pit Fill | DAMS-3046 | 226±24 | C | -37.1 | 150-190 (*0.42*)<br>210-210 (*0.001*)<br>270-310 (*0.49*) | AD 1760-1800<br>AD 1740-1740<br>AD 1640-1680 | Late/ Historic |
| 2E-2G | 23-40 | Matrix ca. Pits | DAMS-3976 | 421±28 | A | -24.0 | 335-350 (*0.05*)<br>440-520 (*0.95*) | AD 1600-1620<br>AD 1430-1510 | Late |
| 2H | 44-56 | House Floor | DAMS-3972 | 3331±34 | C | -22.3 | 3470-3640 (*0.99*)<br>3670-3680 (*0.01*) | 1690-1520 BC<br>1730-1720 BC | Late Early |
| 4 | 87-97 | | DAMS-3047 | 4008±29 | C | -32.0 | 4420-4530 | 2580-2470 BC | Early |
| ECS1 | 120 | | Beta-240182 | 4220±40 | M | 0.5 | 4780-4430 | 2200-1890 BC | |
| 7 | 124-136 | Roasting Pit | DAMS-3048 | 4035±31 | C | -34.3 | 4420-4580 (*0.98*)<br>4770-4780 (*0.02*) | 2630-2470 BC<br>2830-2820 BC | |
| 9 | 156-167 | Roasting Pit | DAMS-3049 | 4157±31 | C | -27.4 | 4580-4770 (*0.80*)<br>4780-4830 (*0.2*) | 2820-2630 BC<br>2880-2830 BC | |
| 10A | 176-180 | | DAMS-3974 | 4445±23 | C | -26.7 | 4960-5070 (*0.59*)<br>5110-5130 (*0.04*)<br>5170-5280 (*0.37*) | 3130-3010 BC<br>3180-3160 BC<br>3330-3220 BC | |
| 10B | 191-201 | | Beta-332396 | 5180±40 | M | 0.3 | 5610-5870 | 3500-3170 BC | |

[1] M = Mussel; C = Corm; A = Manzanita; [2]Multiple age ranges indicate multiple intercepts with probability (*p*) shown

pits (A) and carbonized blue dicks corms (C). While initial occupation at locus 2 occurred between 5870-5610 cal BP, the majority of the deposits (>1 m thick) date to between 5280-4420 cal BP. The fact that more than a meter of deposition occurred largely within a span of a few hundred years (strata 4-10A) at locus 2 suggests that there was either a lot of activity, a relatively large population, or both at this location. The structure feature (stratum 2H) dates between 3640 and 3470 cal BP, slightly younger than the deposits below. However, the strata immediately above the house floor date to the Late/Historic Period, with the hearth clearing pit features dating to cal AD 1640-1800 and the matrix surrounding them dating to cal AD 1430-1510. No Middle Period deposits were documented at locus 2.

The $^{14}C$ date obtained from the uppermost stratum in ECS1, located approximately 1 m west of unit 2, indicates a date range comparable to the date for the structure (stratum 2H). This stratigraphic reversal may easily be explained by the presence of the pit features throughout both units 1 and 2. It is likely that some material from lower deposits were moved up and away during the initial excavation of the pit features. The lateral extent of these pit features is unknown, but multiple pit features were encountered in both units and appear to extend beyond the unit walls in all directions. However, the uppermost deposits at unit 2 (stratum 1 and 1B) both contained callus cup and bushing beads (types K1, K2), as well as triangular dorsally retouched (TDR) microdrills, both of which are indicative of the Late Period. Therefore, strata 1 and 1B of unit 2 are included in discussions of the Late Period deposits rather than late Early Period.

*Locus 3 – The Rockshelter*

Ten $^{14}C$ dates were obtained for various strata at locus 3, with no apparent stratigraphic reversals in the sequence, except for the date for the base of ECS1 (Table 6.6). All the regional cultural periods after 4800 cal BP are represented at locus 3, including the Early, Middle, Transitional, Late, and Historic Periods. Similar to locus 2, the majority of deposition at locus 3 occurred during the Early Period, with initial occupation occurring between 4980-4800 cal BP. Locus 3 deposits contain proportionately more strata dating to the late Early Period than at Locus 2, where most deposits date to the earlier portion of the Early Period. Furthermore, occupation of Diablo Valdez during the Middle Period (stratum 2) is comparatively ephemeral, as is occupation during the Transitional Period. Due to the lack of stratigraphic distinction between the Transitional and Late Period deposits during excavation, general discussions of unit materials combine the Transitional and Late Periods. Nevertheless, occupation at locus 3 occurred largely during the Early and Late Periods, with an apparent gap in occupation of approximately 1500 years between ~2330 and 830 cal BP (380 BC - AD 1120).

Table 6.6. Chronology of Diablo Valdez, Locus 3

| Stratum | Depth (cm) | Lab # | $^{14}C \pm \sigma$ | Material | $^{13}C$ | $^{14}C$ cal BP Age Range ($2\sigma$)[1] | cal AD/BC ($2\sigma$)[2] | Cultural Period |
|---|---|---|---|---|---|---|---|---|
| ECS1 | 0-10 | Beta-282800 | 390±40 | M | 0.2 | 150-160<br>200-210<br>220-440 | AD 1790-1800<br>AD 1740-1750<br>AD 1510-1730 | Late/ Historic |
| 1 | 10-20 | DAMS -3978 | 623±28 | C | -13.2 | 550-615 (*0.60*)<br>615-660 (*0.40*) | AD 1340-1400<br>AD 1290-1330 | Late |
| 1 | 24-34 | DAMS-6165 | 1409±25 | M | | 650-830 | AD 1120-1300 | Trans-itional |
| 2 | 30-40 | DAMS-3973 | 2331±22 | C | -28.4 | 2330-2360 | 410-380 BC | Middle |
| 3 | 41-50 | DAMS-3050 | 2464±25 | C | -27.2 | 2370-2410 (*0.10*)<br>2430-2620 (*0.59*)<br>2630-2710 (*0.31*) | 470-420 BC<br>670-480 BC<br>760-680 BC | Late Early |
| 5 | 60-69 | DAMS-3975 | 2961±21 | C | -25.6 | 3060-3220 (*0.99*)<br>3230-3240 (*0.01*) | 1270-1110 BC<br>1290-1280 BC | |
| 8 | 85-98 | DAMS-3051 | 3320±29 | C | -19.0 | 3470-3630 | 1680-1530 BC | |
| 9 | 114-120 | DAMS-3052 | 3875±33 | C | -28.2 | 4160-4170 (*0.01*)<br>4180-4200 (*0.04*)<br>4230-4420 (*0.95*) | 2220-2210 BC<br>2250-2230 BC<br>2470-2280 BC | Early |
| 11 | 130-169 | DAMS-3967 | 4919±28 | M | 0.9 | 4800-4980 | 3030-2860 BC | |
| ECS1 | 160 | Beta-240183 | 3190±40 | M | 0.2 | 3360-3130 | 920-690 BC | Late Early |

[1] M = Mussel; C = Corm; A = Manzanita; [2]Multiple age ranges indicate multiple intercepts with probability (*p*) shown

## The Artifacts

*Locus 2 – The Saddle*

A variety of artifacts typical of island assemblages dating to within the last 6,000 years was recovered from both Early and Late Period deposits at locus 2. The majority of deposits date to the Early Period, with Late Period deposits occurring only in the upper 40 cm. The artifact assemblages from both early and late deposits (summarized in Table 6.7 below) corroborate the radiocarbon chronology presented above. Artifacts recovered from Early Period deposits are typical of the time period (King 1990). A single, heat-affected opaque white projectile point with a reworked tip (Figure 6.18a), a small worked bone tip (Figure 6.18b), and a broken rectangular abalone bead (Figure 6.18c) were identified in Early Period deposits. Bead types primarily include end ground, barrel, and spire lopped olivella beads, many of which are obliquely ground (Figure 6.18d-g), including an end ground bead that is obliquely ground in both directions, forming a "ridge" on the top (Figure 6.18d). Formal artifacts diagnostic of the Late Period were identified in Late Period deposits only, including triangular dorsally retouched (TDR) microdrills (n=11) and microblades (n=11) of SCRI chert (Figure 6.19a-d), eight callus cup (K1) olivella beads (Figure 6.19f-i), and one deep thick-lipped (E2b) olivella bead (Figure 6.19k). Tiny saucer (G1) olivella beads (n=26) were also recovered only in Late Period deposits at locus 2, although they are known to occur during earlier time periods as well and are therefore not necessarily diagnostic of the Late Period. Three of the callus cup and tiny saucer olivella beads have red ochre staining, exemplified by the bead shown in Figure 6.19i. A single incised abalone rim fragment (Figure 6.19e) was also recovered from Late Period deposits, as was a tiny saucer bead made of red abalone epidermis (Figure 6.19k).

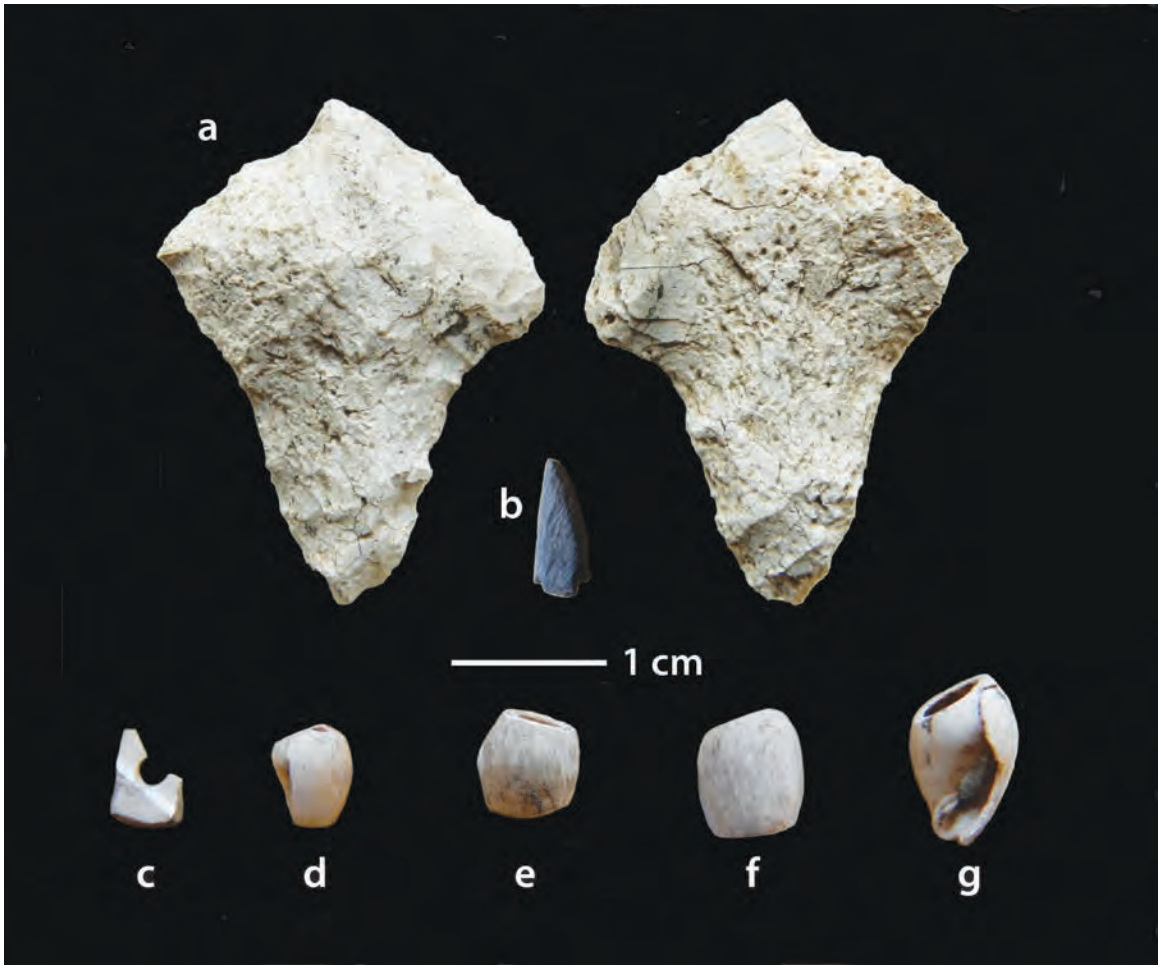


Figure 6.18. Diablo Valdez Early and Late Early Period Artifacts at Locus 2: a) A contracting stem projectile point, reworked (anterior and posterior views), Stratum 10A; b) Small worked bone tip, Stratum 8b; c) Rectangular abalone bead, Stratum 2H (House Floor); d) Double obliquely end ground olivella bead (B2a), Stratum 3; e) Oblique barrel olivella bead (B3b), Stratum 4; f) Oblique end ground olivella bead (B2b), Stratum 5; g) Oblique spire lopped olivella bead (A2b), Stratum 10A (photo by K. Gill).

Chipped stone debitage materials appear to be primarily of local origin, including Santa Cruz Island chert, Monterey chert, chalcedony, and coarse and fine-grained volcanic materials. Obsidian was identified in low counts from both Early (n=1) and Late Period (n=1) deposits. X-ray fluorescence analysis by Richard Hughes (Geochemical Research Laboratory) of the Late Period obsidian flake indicates it came from the West Sugarloaf

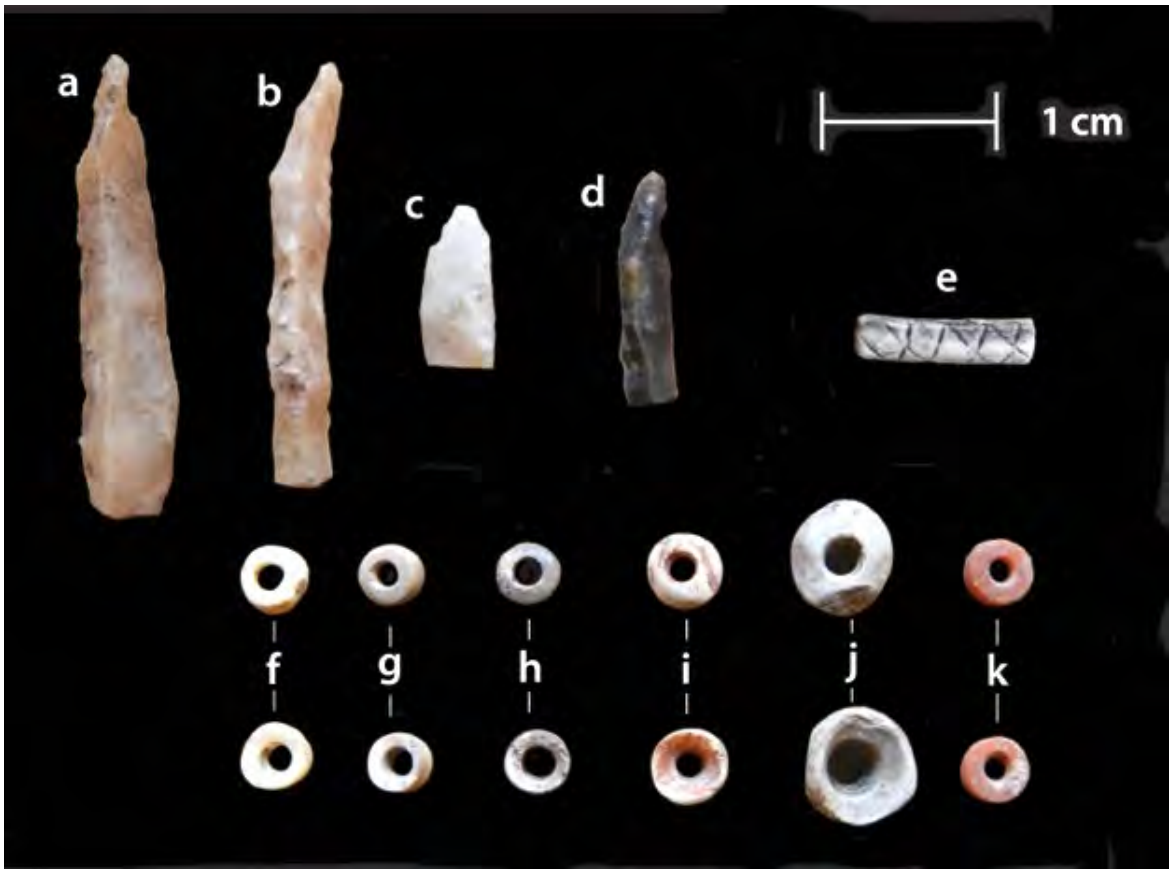


Figure 6.19. Diablo Valdez Late Period Artifacts at Locus 2: a-d) Santa Cruz Island chert TDR Microdrills; e) Incised abalone solid cylinder (Stratum 1B); f-i) Callus cup olivella beads (K1); j) Deep thick-lipped olivella bead (E2b); and k) tiny saucer (G1) Red Abalone epidermis bead.

source in the Coso Volcanic Field (Hughes 2014), where the majority of island obsidians originate (Rick et al. 2001). This indicates that the inhabitants of Diablo Valdez during the Late Period were involved to a certain extent in regional exchange networks. The obsidian recovered from Early Period deposits also points to earlier involvement with regional exchange networks but was too small to produce an XRF reading.

Table 6.7. Summary of Artifact Counts at Diablo Valdez, Locus 2, Unit 2, by Time Period

| Type | Material | Early | Late Early | Late |
|---|---|---|---|---|
| *Chipped Stone Artifacts* | | | | |
| Projectile Point | SCRI Chert | 1 | -- | -- |
| Microdrill – TDR | SCRI Chert | -- | -- | 11 |
| Microblade - TDR | SCRI Chert | -- | -- | 11 |
| Utilized Flake | SCRI Chert | 7 | 5 | 10 |
| Utilized Flake | Monterey Chert | 1 | -- | -- |
| Utilized Flake | Fine-grained Volcanic | 1 | -- | -- |
| Core | SCRI Chert | -- | -- | 5 |
| Debitage | SCRI Chert | 61 | 5 | 21 |
| Debitage | Monterey Chert | 1 | -- | -- |
| Debitage | Fine-grained Volcanic | 15 | 3 | 22 |
| Debitage | Volcanic | 13 | 4 | 2 |
| Debitage | Chalcedony | -- | -- | 1 |
| Debitage | Obsidian | 1 | -- | 1 |
| Debitage | UnID Opalescent | 1 | -- | -- |
| *Shell Artifacts* | | | | |
| Tiny saucer bead (G1) | *Mytilus* sp. | -- | -- | 1 |
| Tiny saucer bead (G1) | *Haliotis rufescens* | -- | -- | 1 |
| Rectangular bead | *Haliotis* spp. | -- | 1 | -- |
| Tiny saucer bead (G1) | Olivella | -- | -- | 26 |
| Callus cupped bead (K1) | Olivella | -- | -- | 8 |
| Bushing bead (K2) | Olivella | -- | -- | 15 |
| Deep thick-lipped (E2b) | Olivella | -- | -- | 1 |
| Round thin-lipped (E1a1) | Olivella | -- | -- | 3 |
| Rough disk bead (H2) | Olivella | -- | -- | 1 |
| Oblique end ground bead (B2a, B2b) | Olivella | 1 | 1 | -- |
| End ground bead (B2a, B2b) | Olivella | 7 | 1 | -- |
| Oblique spire lopped bead (A2a, A2b) | Olivella | 2 | -- | -- |
| Spire lopped bead (A2a, A2b) | Olivella | 1 | -- | 1 |
| Oblique barrel bead (B3a, B3b) | Olivella | 1 | 1 | -- |
| Barrel bead (B3a, B3b) | Olivella | 1 | 1 | -- |
| Wall BIP | Olivella | -- | -- | 4 |
| Cup BIP | Olivella | -- | -- | 1 |
| Wall triangular BIP | Olivella | 1 | -- | -- |
| Wall rectangular BIP | Olivella | 1 | -- | -- |
| Incised abalone rim | *Haliotis* spp. | -- | -- | 1 |
| Detritus | Olivella | 9 | -- | 198 |
| Detritus | *Tivela* | -- | -- | 1 |
| *Bone Artifacts* | | | | |
| Worked bone tip | Mammal | 1 | -- | -- |
| *Other* | | | | |
| Mineral | Red Ochre | 28 | -- | 1 |
| Mineral | Asphaltum | 3 | -- | 4 |

While Monterey chert identified on the islands is sometimes associated with mainland chert sources, sources of similar material have been found on San Miguel Island (Erlandson et al. 2008). The Monterey formation does occur on Santa Cruz Island, including in the area around Cueva Valdez, downslope and west of the Diablo Valdez site, and recent geoarchaeological surveys have found cobbles and bedrock exposures containing "mainland" Monterey cherts. It is therefore conceivable that the Monterey chert recovered from this site came from a nearby source rather than from the mainland. Volcanic and fine-grained volcanic materials are also likely obtained from nearby beach cobbles or from cobbles eroding from the local breccia or raised beaches. Most of the SCRI chert identified ranged from the typical light brown to honey to blond shades, as well as white and dark brown (see Figures 6.18 and 6.19), typical of well-known sources on eastern SCRI. However, several pieces of SCRI chert were either obviously heat-affected or opaque white mottled with gray, or they had a notable sheen that presumably occurred during heating. An unidentified rock type with an opalescent sheen was also recovered. Utilitarian minerals recovered include both red ochre and asphaltum, seen in both Early and Late Period deposits. These, too, are most likely of local origin (Gill and Erlandson 2014).

*Locus 3 – The Rockshelter*

The artifact types identified at locus 3 also correspond well with the radiocarbon chronology, summarized as raw counts per time period in Table 6.8. Late Period TDR microdrills (n=4)/blades (n=2), as well as olivella callus cup (K1) (n=1) and bushing (K2) (n=1) beads occur in the Late Period deposits only, whereas other artifacts such as olivella barrel beads (B3) (n=3) and a rectangular bead were found in Early Period deposits. Worked

Table 6.8. Summary of Artifact Counts at Diablo Valdez, Locus 3, Unit 2, by Time Period

| Type | Material | Early | LE | Middle | Late/Trans |
|---|---|---|---|---|---|
| *Chipped Stone Artifacts* | | | | | |
| Microdrill - TDR | SCRI Chert | -- | -- | -- | 4 |
| Microblade | SCRI Chert | -- | -- | -- | 2 |
| Utilized flake | SCRI Chert | 3 | 2 | 4 | 4 |
| Utilized flake | Monterey Chert | -- | -- | -- | 7 |
| Utilized flake | FG Volcanic | -- | -- | 1 | 3 |
| Scraper | SCRI Chert | -- | -- | 1 | -- |
| Core | Volcanic | -- | -- | -- | 1 |
| Debitage | SCRI Chert | 34 | 15 | 11 | 3 |
| Debitage | Monterey Chert | 1 | 1 | 1 | 1 |
| Debitage | FG Volcanic | 12 | 9 | 23 | 3 |
| Debitage | Volcanic | -- | 9 | -- | -- |
| Debitage | Chalcedony | -- | -- | 1 | -- |
| Debitage | Siliceous Shale | -- | -- | -- | 1 |
| Debitage | Quartzite | -- | -- | -- | 4 |
| | | | | | |
| *Shell Artifacts - Beads* | | | | | |
| Tiny saucer (G1) | Olivella | -- | -- | 1 | 1 |
| Ground saucer (G4) | Olivella | -- | -- | -- | 1 |
| Callus cup (K1) | Olivella | -- | -- | -- | 1 |
| Bushing (K2) | Olivella | -- | -- | 1 | -- |
| Shelved thick rectangle (L2b) | Olivella | 1 | -- | -- | -- |
| Semi-ground needle drilled (H1b) | Olivella | -- | -- | -- | 1 |
| Oblique spire lopped (A2b) | Olivella | -- | -- | 1 | -- |
| Simple spire lopped (A1a, A1b) | Olivella | 1 | -- | -- | 1 |
| Barrel (B3a, B3b) | Olivella | -- | 3 | -- | -- |
| Wall BIP | Olivella | 1 | -- | -- | -- |
| Detritus | Olivella | 2 | -- | 7 | 20 |
| Detritus | *Tivela* | -- | -- | 2 | 5 |
| | | | | | |
| *Bone Artifacts* | | | | | |
| Worked bone with asphaltum | Deer | -- | 1 | -- | -- |
| Worked bone | Mammal | 1 | -- | -- | -- |
| | | | | | |
| *Mineral* | | | | | |
| Red ochre | | 3 | -- | -- | -- |
| Asphaltum | | -- | -- | 1 | -- |


Figure 6.20. Worked Deer Bone Tool Tip with Asphaltum and Cut Mark at Base, from Stratum 8 (Late Early Period), Locus 3 (photo by K. Gill).

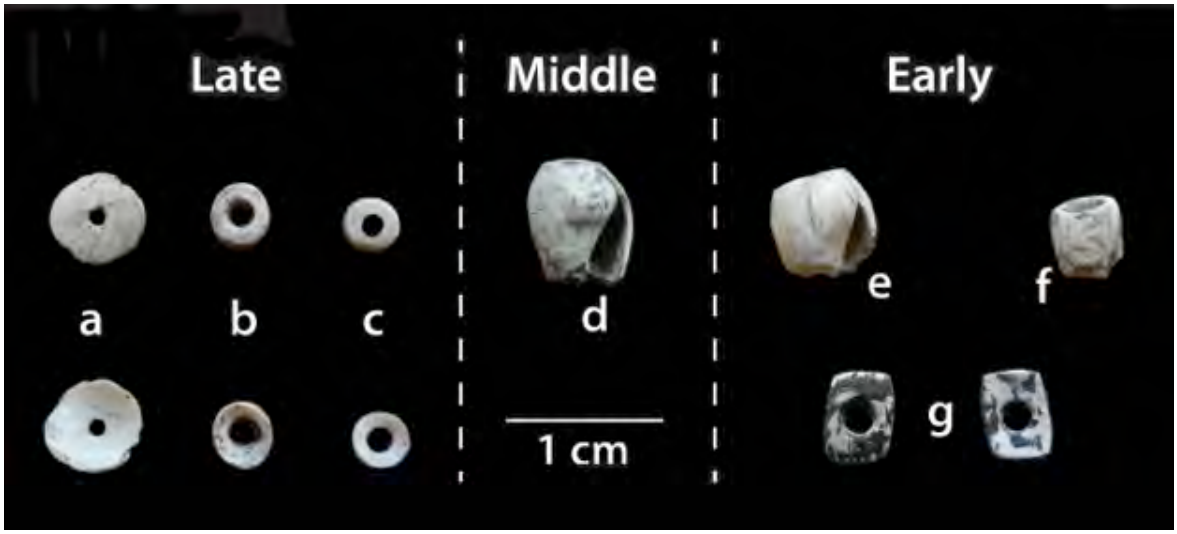


Figure 6.21. Locus 3 Late, Middle and Early Period *Olivella* beads. a) Semi-Ground Needle Drilled (H1b), Stratum 1 (0-10 cm); b-c) Callus Cupped (K1), Stratum 1 (10-20 cm); d) Oblique Spire Lopped (A2b), Stratum 2; e) Oblique Barrel (B3a), Stratum 6; f) Oblique Barrel (B3a), Stratum 7; g) Unshelved Small Thick Rectangle (L2b), Stratum 10B (Composite Photo by K. Gill).

mammal bone is also present in small amounts, including a tip of a deer bone artifact with asphaltum adhering that appears to have been intentionally snapped at the base (Figure 6.20) from Early Period deposits. Although this artifact is the only piece of deer bone identified at the site, its presence is indicative of involvement with regional exchange networks in place during the Early Period, with deer bone presumably coming from the adjacent mainland.

Early Period shell beads include an unshelved small rectangle with asphaltum (Figure 6.21g), as well as oblique barrel beads (e, f). Middle Period deposits produced only two beads, including a slightly oblique spire-lopped (Figure 6.21d) and a tiny saucer bead. Late Period deposits yielded tiny saucer beads, as well as callus cupped and bushing beads made from olivella shells (Figure 6.21, b, c). A single needle drilled bead (diameter 6.04 mm, perforation 0.85 mm) found in the uppermost portions of the deposit is indicative of the Historic Period, after the Spanish introduced metal needles. This bead type is the only diagnostic artifact indicative of Historic Period occupation at the site, but it corroborates historic era $^{14}C$ dates for the uppermost strata at both loci. No glass trade beads were identified at the site, although they are often found at Historic Period sites on the islands (see Sutton 2014).

Lithic material types recovered from locus 3 are similar to those recovered from locus 2 and discussed above, providing further support for the use of primarily local lithic sources.

## Faunal Remains

### *Shellfish*

Although not analyzed in detail here, shellfish remains are abundant at the Diablo Valdez site. They were dominated by California mussels, but large acorn barnacles and other species from rocky intertidal habitats as well as small amounts of *Tivela*, are present.

### *Bone*

Because volume per stratum was not calculated during excavation due to the complicated stratigraphy, raw weights of shellfish and each class of bone, as well as the relative proportion (ratio) of shellfish weight (g) to total bone weight (g) for each stratum is summarized in Table 6.9 for locus 2 and 6.10 for locus 3. The majority of the mammal bone is of sea mammal, with no obvious deer or other large terrestrial mammal bone noted in the unit 2 material from either locus. Rodent and unidentified bone, both of which occur in very small amounts, is not presented here. Feature strata are highlighted in gray. All shellfish and bone weights reported here were recovered from the 1/8-inch screened unit 2 material. As a result, bones from very small-bodied fish (e.g., sardines) are probably not well represented, although small schooling fish are not as common in island assemblages as they are on the mainland (Pletka 2001).

In general, both loci at Diablo Valdez have very high shellfish to total bone weight ratios, demonstrating that shellfish remains dominate the faunal assemblage. Very high proportions of shellfish to bone have been documented elsewhere in Santa Cruz Island assemblages, where the shellfish remains often comprise 95-99.9% of the total faunal assemblage at various sites (see Glassow 1980). Some island coastal sites do have

Table 6.9. Diablo Valdez Bone and Shell Weight (g) Ratios, at Locus 2 (Features in Gray)

| Time | Stratum | Shell (g) | Mammal (g) | Bird (g) | Fish (g) | Shell:Bone |
|---|---|---|---|---|---|---|
| Late Period | 1 | 19,949 | 6.99 | 0.33 | 2.18 | 2100:1 |
| | 1B | 17,789 | 12.78 | 2.41 | 2.28 | 1018:1 |
| | 2B-1 | 769 | 0.32 | -- | 0.5 | 938:1 |
| | 2E | 13,755 | 16.34 | 1.32 | 6.36 | 573:1 |
| | 2F, G | 16,007 | 13.55 | 0.36 | 2.78 | 959:1 |
| Late Early Period | 2H | 4432 | 1.22 | 0.09 | 0.78 | 2121:1 |
| | 3 | 98,747 | 4.31 | 1.02 | 8.25 | 7272:1 |
| | 4 | 35,494 | 5.34 | 0.1 | 2.04 | 4745:1 |
| Early Period | 5 | 19,821 | 1.05 | 0.19 | 1.71 | 6719:1 |
| | 6 | 17,709 | 0.35 | 0.16 | 0.97 | 11,966:1 |
| | 7 | 15,340 | 2.67 | 0.81 | 1.08 | 3364:1 |
| | 8A | 17,577 | -- | 0.15 | 2.99 | 5598:1 |
| | 8B | 7425 | 2.5 | 0.21 | 3.11 | 1276:1 |
| | 9 | 15,922 | 8.91 | 1.3 | 4.25 | 1101:1 |
| | 10A | 14,584 | 11.48 | 2.44 | 8.41 | 653:1 |
| | 10B | 3452 | 0.1 | 0.17 | 0.26 | 6513:1 |

Table 6.10. Diablo Valdez Bone and Shell Weight (g) Ratios, at Locus 3

| Time | Stratum | Shell (g) | Mammal (g) | Bird (g) | Fish (g) | Shell:Bone |
|---|---|---|---|---|---|---|
| Late Period | 1 | 36,651 | 19.55 | 0.69 | 39.62 | 612:1 |
| | 1A | 8975 | 0.66 | 0.1 | 2.28 | 2952:1 |
| Middle | 2 | 26,606 | 4.47 | 2.04 | 8.76 | 1742:1 |
| | 2A | 10,179 | 1.75 | 0.08 | 0.85 | 3798:1 |
| Late Early | 3 | 3502 | -- | -- | 0.48 | 7296:1 |
| | 4 | 3757 | 0.33 | 0.04 | 0.77 | 3296:1 |
| | 5 | 13,858 | 6.55 | 1.81 | 3.32 | 1186:1 |
| | 6 | 7874 | 2.39 | 1.14 | 3.99 | 1047:1 |
| | 7 | 13,986 | 5.74 | 0.37 | 1.03 | 1959:1 |
| | 8 | 26,000 | 0.96 | 1.37 | 2.47 | 5417:1 |
| Early | 9 | 9231 | -- | 0.59 | 0.23 | 11,257:1 |
| | 10A | 8236 | 0.36 | 0.99 | 0.83 | 3778:1 |
| | 10B | 15,216 | 0.63 | 1.61 | 8.36 | 1435:1 |
| | 11 | 12,397 | 0.66 | 2.96 | 1.26 | 2540:1 |
| | 12 | 2107 | 0.16 | 3.72 | 0.63 | 467:1 |

higher proportions of bone, however, including the Punta Arena site, where dolphin hunting was important (Glassow et al. 2008). Colten (2001) also reported faunal data from four coastal sites on western Santa Cruz dating from the Middle Period through the Historic (CA-

SCRI-192, -240, -330, and -474). The shell to bone ratios at these coastal sites are much smaller (between 81:1 and 113:1 for shell to bird and mammal combined, and between 31:1 and 59:1 for shell to fish) (Colten 2001) than those seen at the Diablo Valdez site. .

The large differences in the shell to bone ratios seen at the Diablo Valdez site compared with coastal sites on the island that date to similar periods may be a product of processing decisions for fauna imported to the interior. Given the high elevation of the Diablo Valdez site and steepness of the northern coast, it is possible that the majority of faunal resources (particularly marine mammals) were processed near the coast, with only certain parts carried up to the Diablo Valdez site. Shellfish, on the other hand, can be transported alive in their shells over long distances, and will remain alive for several days (Hildebrant et al. 2009). Therefore, processing decisions may account for the high ratios of shellfish to bone seen at this site.

By combining both loci at Diablo Valdez, we can use boxplots to test for significant change in shell to bone ratios for each class through time. Figures 6.22 – 6.24 show the ratios of shell to sea mammal, bird, and fish bone (respectively) through time using notched box plots, with all feature data excluded to show general subsistence trends. It is important to note that with these ratios, the smaller the number on the vertical axis, the higher the proportion of bone there is to shellfish remains. In Figure 6.22, we see a decrease in the ratio of shell to sea mammal bone through time, which equates to a statistically significant increase in sea mammal bone relative to shellfish during the Late Period, compared with the Early Period. However, there is no significant difference between the Early and Late Early

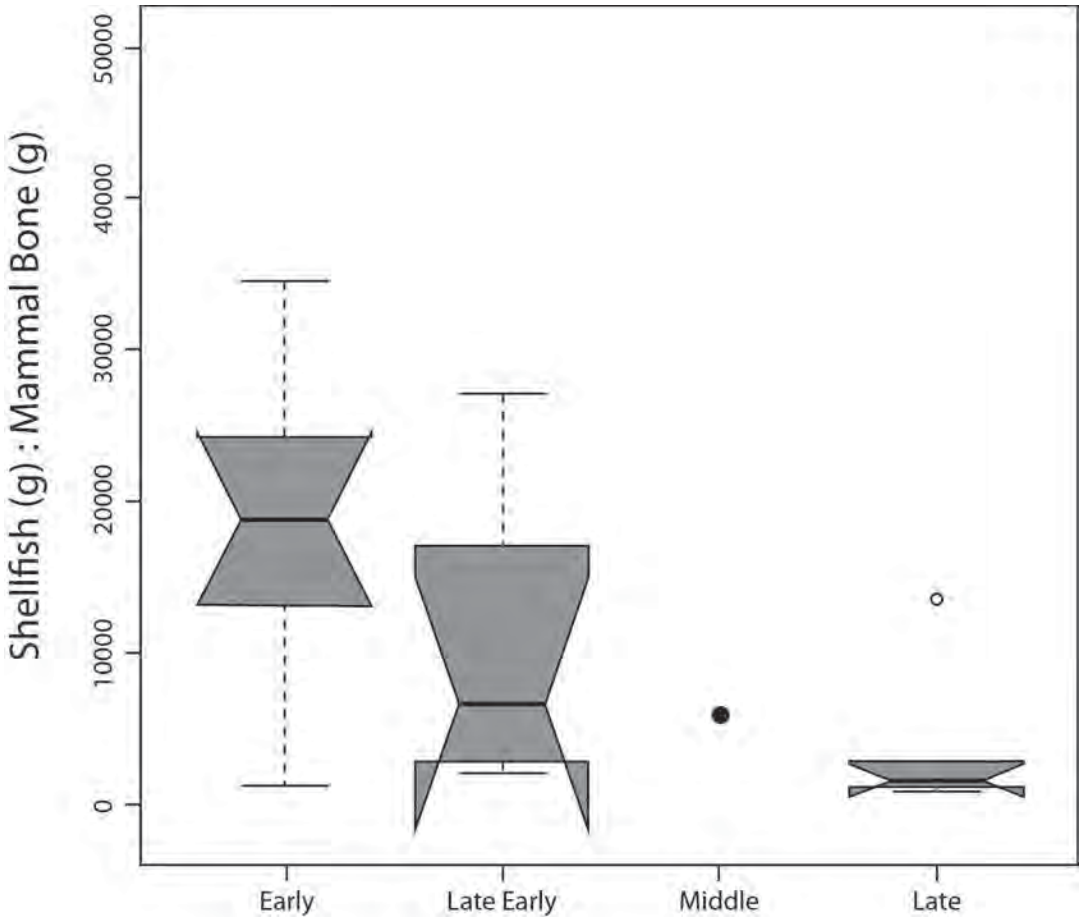


Figure 6.22. Box Plots of Shell to Mammal Bone Ratios at Diablo Valdez by Time Period

Periods, or between the Late Early and Late Periods, suggesting the increase in sea mammal was gradual through time. The ratio of shellfish to bird bone does not change significantly through time, and while there may be a slight increase in fish bone relative to shellfish during the Late Period, it is not statistically significant.

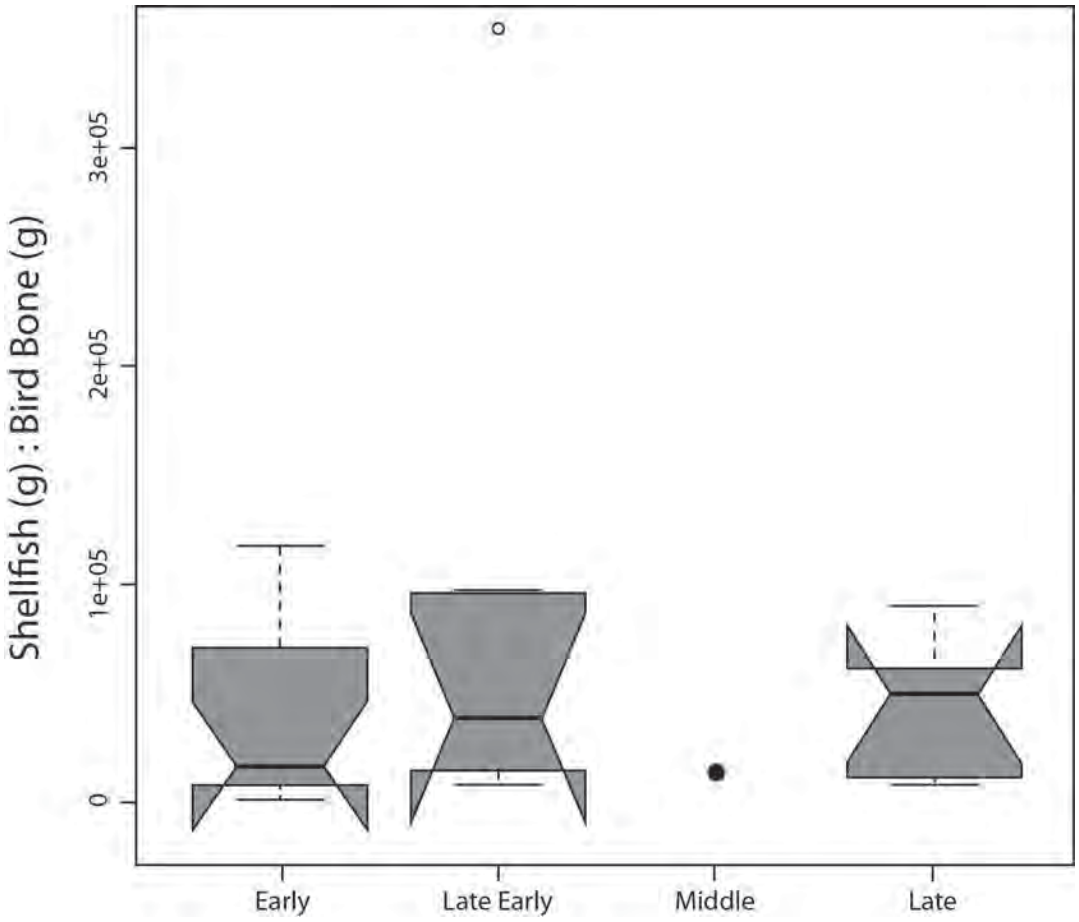


Figure 6.23. Box Plots of Shell to Bird Bone Ratios at Diablo Valdez by Time Period

The increase in sea mammal remains at Diablo Valdez is consistent with other Santa Cruz Island sites dating to the Middle and Late Periods. It has been suggested that the plank canoe, or *tomol,* made sea mammal hunting easier and more efficient than with other types of boats (see Colten 2001), but that sea mammals were still largely supplemental to other marine resources. However, considering data from all the islands, Rick et al. (2005:210) noted that "sea mammal hunting varied on each of the islands, with some of the greatest hunting occurring on more distant islands (e.g., San Miguel, San Clemente)." Bird bone generally occurs in relatively low densities at sites on the islands, and birds seem to have been largely supplemental to island diets throughout the Holocene (Colten 2001; Rick et al. 2005).

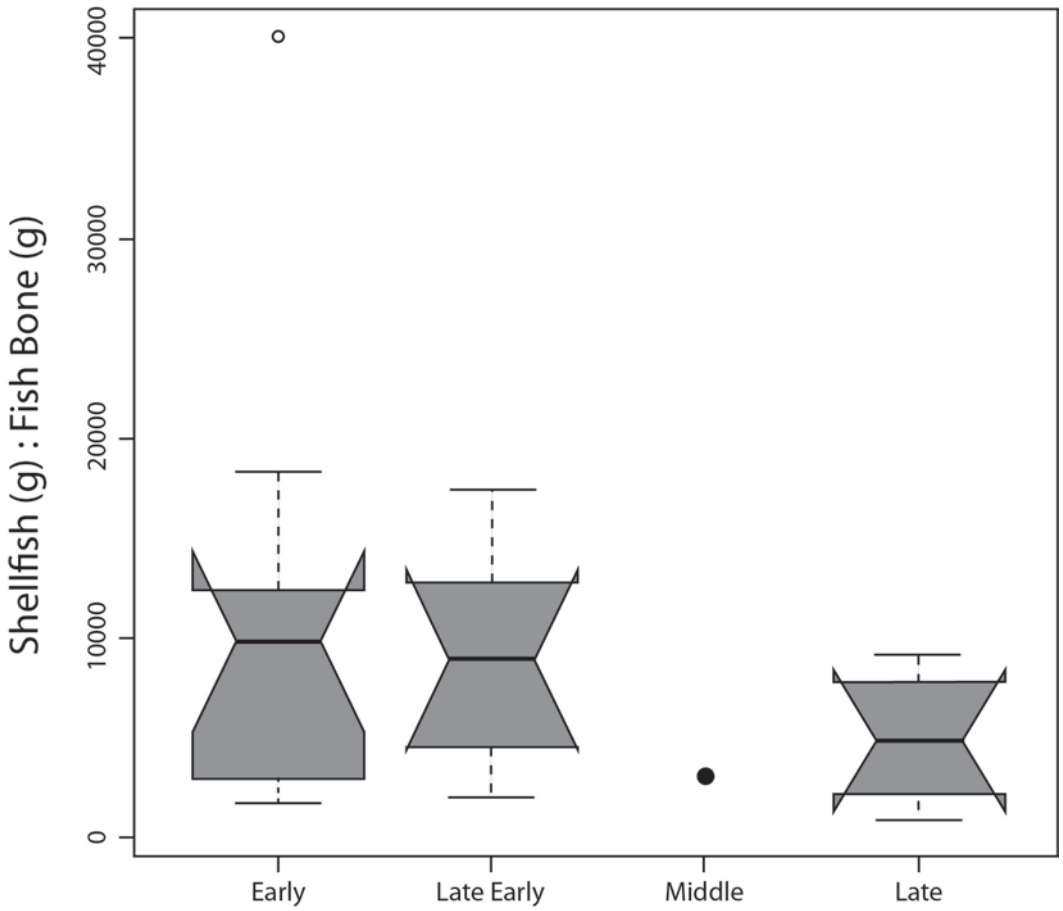


Figure 6.24. Box Plots of Shell to Fish Bone Ratios at Diablo Valdez by Time Period

On the other hand, the relative importance of fish in island diets has long been described as generally increasing in the later Holocene, particularly pelagic fish, as populations increased (Arnold and Bernard 2005; Rick et al. 2005; Kennett 2005; Noah 2005; Raab et al. 2002; Rick 2004; Vellanoweth and Erlandson 1999). Stable isotope data derived from human skeletal remains generally support an increasing reliance on fish, as described in the ethnohistorical literature (Walker and DeNiro 1986). The fish remains at the Diablo Valdez site, however, show no statistically significant change through time relative to shellfish.

**Paleoethnobotanical Remains**

Abundant and diverse paleoethnobotanical remains were recovered from the Diablo Valdez site, in both the light fraction column samples (140 liters of soil analyzed) and the 1/8-inch screened unit material. The carbonized remains of at least 38 distinct plant genera were identified at Diablo Valdez, 36 of which are edible, medicinal or were used to make tools. Archaeobotanical remains from screened unit material are presented first, followed by data from the light fraction column samples. The screened unit material produced large quantities of carbonized brodiaea corms, as well as several large plant remains that were not found in the column samples, including a wild cherry, a toyon, and a large pine seed. Further discussion and quantitative analysis of the paleoethnobotanical remains is provided in Chapter 7.

*Locus 2 – The Saddle*

Table 6.13 presents the raw weight (g) of archaeobotanical remains recovered from the 1/8-inch screened material. The two most commonly recovered taxa were brodiaea corms, corm fragments, and manzanita berry pits. Both taxa were recovered from deposits dating to all time periods and nearly all strata, and the largest amount of brodiaea corms was recovered from the well-defined roasting pit feature (stratum 7). Other taxa recovered from screened material at Locus 2 include wild cucumber, California wax myrtle, and wild cherry.

Table 6.13. Diablo Valdez Paleoethnobotanical Remains (g) from Locus 2, Unit 2 (1/8-inch screened) Material with Feature Strata Highlighted in Gray

| Stratum | Wood Charcoal | Brodiaea | Manzanita | Wild Cucumber | Wax Myrtle | Wild Cherry |
|---|---|---|---|---|---|---|
| 1 | 90.67 | 0.26 | .011 | -- | -- | -- |
| 1B | 148.93 | 0.13 | 0.14 | 0.02 | -- | -- |
| 2E-G | 26.51 | 2.97 | 2.85 | -- | 0.07 | 0.02 |
| 2H | 0.79 | 0.1 | -- | -- | -- | -- |
| 3 | 13.7 | 0.93 | 0.09 | -- | -- | -- |
| 4 | 0.46 | 0.38 | <0.01 | -- | -- | -- |
| 5 | 19.2 | 0.79 | 0.07 | -- | -- | -- |
| 6 | 8.69 | 1.28 | <0.01 | -- | -- | -- |
| 7 | 10.15 | 20.25 | 0.02 | -- | -- | -- |
| 8A | 34.96 | 1.69 | 0.06 | -- | -- | -- |
| 8B | 3.23 | 1.03 | 0.14 | -- | -- | -- |
| 9 | 6.26 | 0.5 | 0.04 | -- | -- | -- |
| 10A | 7.39 | 1.65 | 0.13 | -- | -- | -- |
| 10B | 0.56 | -- | -- | -- | -- | -- |

Wild cucumber seeds (*Marah* sp.) were found in small amounts in stratum 1B, yet it is much better represented in flotation samples, as it tends to break into small pieces easily. Wild cherry (*Prunus ilicifolia*) was identified in the screened material but was not represented in the flotation samples. Substantial numbers of brodiaea corms were also recovered from a discrete concentration in unit 1, adjacent to the roasting pit feature (Figure 6.25). The incredible abundance of these archaeobotanical brodiaea corms associated with the stratum 7 roasting pit feature strongly suggest that the primary function of this feature was for roasting brodiaea corms. The dimensions and structure of this feature also appear to correlate well with the *cacomite* roasting pits described ethnographically by Fernando Librado (Chapter 3).


Figure 6.25. Carbonized Brodiaea Corms (45.21 g) associated with the Roasting Pit Feature in Unit 1, Locus 2, Diablo Valdez (photo by K. Gill).

*Locus 3 – The Rockshelter*

Carbonized brodiaea corms were also noted during excavation at Locus 3, although not in such high abundance as at Locus 2. Table 6.14 presents the raw weight (g) of archaeobotanical remains recovered from the screened material at locus 3. Brodiaea corms and corm fragments were recovered from the screened material of nearly every stratum (no archaeobotanical remains were recovered from stratum 12). Manzanita berry pits were also

Table 6.14. Diablo Valdez Paleoethnobotanical Remains, Locus 3, Unit 2 (1/8-inch screened) Material, With Feature Strata Highlighted in Gray

| Stratum | Wood Charcoal | *Brodiaea* | *Arctostaphylos* sp. | *Marah* sp. | *Heteromeles* sp. | *Pinus* sp. |
|---|---|---|---|---|---|---|
| 1 | 13.48 | 0.71 | 0.02 | 0.06 | 0.05 | -- |
| 1A | 7.83 | 5.11 | -- | -- | -- | -- |
| 2 | 18.66 | 8.4 | <0.01 | 0.09 | -- | -- |
| 2A | 20.49 | 0.12 | -- | -- | -- | -- |
| 3 | 8.24 | 0.05 | -- | -- | -- | -- |
| 4 | 251.09 | 0.15 | -- | 0.02 | -- | -- |
| 5 | 9.03 | 1.06 | -- | -- | -- | -- |
| 6 | 2.23 | 0.1 | 0.01 | -- | -- | -- |
| 7 | 5.34 | 0.53 | -- | -- | -- | 0.19 |
| 8 | 18.33 | 0.36 | 0.02 | <0.01 | -- | -- |
| 9 | 0.26 | 0.09 | -- | -- | -- | -- |
| 10A | 4.61 | 0.6 | -- | -- | -- | -- |
| 10B | 3.99 | 0.53 | -- | -- | -- | -- |
| 11 | 1.94 | 0.55 | -- | -- | -- | -- |

recovered from various strata, as were wild cucumber seeds, both of which are well represented in the light fraction samples. Two taxa, toyon and pine, were recovered in the screened unit material but were not recovered in the flotation samples. The pine seed is too large to be from the local Bishop pine (*P. muricata*), and was most likely imported from either the mainland (where a variety of large-seeded pines occur including gray (*P. sabiniana*), pinyon (*P. monophylla*), and Jeffrey pine (*P. jeffreyi*)) or Santa Rosa Island, where the large-seeded Pleistocene relic Torrey pine (*P. torreyana*) occurs. Identification of the pine seed to species is not possible at this time, but nevertheless it represents a plant food that was brought to the Diablo Valdez site during the Late Early Period, either from Santa Rosa Island or the mainland.

*Light Fraction Column Samples*

The paleoethnobotanical remains recovered from the light fraction portion of the column samples are divided into large and small, with the density per liter of both counts and

weights presented for large remains, and density per liter of counts only for small remains reported in the tables below (Tables 6.15-6.20). Tables with raw count and weight data are presented in Appendix B. A total of 76.6 liters of soil from Locus 2 and 63.5 liters from Locus 3 were processed using flotation and analyzed. Overall, the archaeobotanical remains identified at both loci largely reflect the habitat types near the Diablo Valdez site today, including open grassland, chaparral, oak woodland and wetland plant communities. Except for California wax myrtle and the large pine seed, these remains probably reflect the predominant use of locally available plant resources.

Table 6.15. Density of Early Period Archaeobotanical Remains, Locus 2 (Strata 4-7).

| **Stratum** | | | **4A** | **5** | **6A** | **6B** | **7** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **80-90** | **90-109** | **109-115** | **115-130** | **130-135** |
| **Feature** | | | | | | | **RP[2]** |
| **Volume (liters)** | | | **5.75** | **6.75** | **2.00** | **6.25** | **2.125** |
| **Time Period** | | **/L** | **Early Period** | | | | |
| Scientific Name | Common Name | | | | | | |
| Large Taxa | | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 6.96 | 3.26 | 7 | 3.2 | 1.41 |
| | | g | 0.07 | 0.04 | 0.01 | 0.04 | 0.002 |
| *Marah* | Wild Cucumber | n | 0.35 | -- | -- | 0.16 | -- |
| | | g | 0.001 | -- | -- | 0.001 | -- |
| *Quercus* | Acorn Nutshell | n | -- | 0.44 | -- | -- | -- |
| | | g | -- | 0.002 | -- | --- | -- |
| UnID Nutshell | | n | -- | -- | -- | -- | 0.94 |
| | | g | -- | -- | -- | -- | 0.005 |
| Wood Charcoal | | g | 1.12 | 0.47 | 0.15 | 0.27 | 0.91 |
| Small Taxa | | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | -- | -- | -- | -- |
| *Atriplex* spp. | Saltbush | n | -- | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | 0.17 | -- | 0.5 | -- | -- |
| *Chenopodium* spp. | Goosefoot | n | -- | -- | 0.5 | 0.32 | -- |
| *Eriogonum* spp. | Buckwheat | n | -- | -- | -- | 0.64 | -- |
| *Euphorbia* spp. | Spurge | n | -- | 0.15 | -- | -- | -- |
| *Hypericum* spp. | Tinker's Penny | n | -- | -- | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | -- | -- | 0.8 | 0.47 |
| *Poa* spp. | Blue Grass | n | -- | -- | -- | -- | -- |
| *Ruppia* spp. | Ditchgrass | n | -- | -- | -- | -- | 0.94 |
| *Salvia* spp. | Chia, Sage | n | -- | -- | -- | -- | -- |
| *Sisyrinchium* spp. | Blue Eyed Grass | n | -- | 0.15 | -- | -- | -- |
| Asteraceae | Sunflower Family | n | -- | -- | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | 1.33 | -- | -- | 2.35 |
| Fabaceae | Bean Family | n | 0.17 | -- | -- | -- | -- |
| Poaceae | Grass Family | n | -- | 0.15 | -- | 0.16 | 0.47 |
| Amorphous | | n | -- | 5.04 | 1 | 3.36 | 1.41 |
| | | g | -- | 0.01 | -- | 0.005 | -- |
| Centrospermae | | n | -- | -- | -- | 0.16 | 0.47 |
| Unidentified Seeds | | n | -- | 0.15 | -- | -- | 0.47 |
| Unidentified Seed Fragments | | n | 0.35 | 0.89 | -- | 2.88 | -- |
| Total Identified to Genus | | n | 0.17 | 0.3 | 1 | 1.76 | 1.41 |
| Total Identified to Family | | n | 0.17 | 1.48 | -- | 0.16 | 2.82 |

[2]RP=Roasting Pit

Table 6.15 (cont.). Density of Early Period Archaeobotanical Remains, Locus 2 (Strata 8-10)

| **Stratum** | | | **8A** | **8B** | **9** | **10A** | **10B** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **135-144** | **146-162** | **159-172** | **172-191** | **191-201** |
| **Feature** | | | | | **RP** | | |
| **Volume (liters)** | | | **3.00** | **5.75** | **1.25** | **7.25** | **2.50** |
| **Time Period** | | **/L** | **Early Period** | | | | |
| Scientific Name | Common Name | | | | | | |
| Large Taxa | | | | | | | |
| *Arctostaphylos* | Manzanita | n | 0.33 | 2.09 | -- | 0.14 | -- |
| | | g | 0.02 | 0.01 | -- | 0.001 | -- |
| Brodiaea s.l. | Brodiaea | n | 10.33 | 6.61 | 0.8 | 2.62 | 0.80 |
| | | g | 0.05 | 0.06 | 0.02 | 0.01 | 0.002 |
| *Marah* | Wild Cucumber | n | -- | -- | 0.8 | 0.41 | 2.00 |
| | | g | -- | -- | 0.004 | 0.003 | 0.002 |
| *Quercus* | Acorn Nutshell | n | -- | -- | 1.60 | 0.69 | -- |
| | | g | -- | -- | 0.004 | 0.003 | -- |
| | Acorn Cap | n | -- | 0.17 | -- | -- | -- |
| | | g | -- | 0.001 | -- | -- | -- |
| UnID Nutshell | | n | -- | 0.52 | -- | -- | -- |
| | | g | -- | 0.001 | -- | -- | -- |
| Wood Charcoal | | g | 0.63 | 0.48 | 0.09 | 0.06 | 0.04 |
| Small Taxa | | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | 0.17 | -- | -- | -- |
| *Atriplex* spp. | Saltbush | n | 0.33 | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | -- | -- | -- | -- | -- |
| *Chenopodium* spp. | Goosefoot | n | 0.33 | -- | -- | -- | -- |
| *Eriogonum* spp. | Buckwheat | n | -- | -- | -- | -- | -- |
| *Euphorbia* spp. | Spurge | n | -- | -- | -- | -- | -- |
| *Hypericum* spp. | Tinker's Penny | n | -- | -- | -- | -- | 0.4 |
| *Phacelia* spp. | Phacelia | n | 0.33 | 0.87 | -- | -- | -- |
| *Poa* spp. | Blue Grass | n | 0.33 | -- | -- | -- | -- |
| *Ruppia* spp. | Ditchgrass | n | -- | -- | -- | -- | -- |
| *Salvia* spp. | Chia, Sage | n | 0.33 | -- | -- | -- | -- |
| *Sisyrinchium* spp. | Blue Eyed Grass | n | -- | -- | -- | -- | -- |
| Asteraceae | Sunflower Family | n | -- | 0.17 | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | 1.39 | -- | 0.28 | -- |
| Fabaceae | Bean Family | n | 0.67 | 0.52 | -- | -- | -- |
| Poaceae | Grass Family | n | 0.67 | 1.91 | 4.8 | -- | -- |
| Amorphous | | n | 1.67 | 0.87 | 3.2 | 2.48 | 0.4 |
| | | g | 0.01 | 0.001 | -- | 0.001 | -- |
| Centrospermae | | n | 1 | 0.35 | 0.8 | -- | -- |
| Unidentified Seeds | | n | -- | 0.17 | 2.4 | 0.14 | 1.2 |
| Unidentified Seed Fragments | | n | 5.67 | 1.39 | -- | 0.28 | -- |
| Total Identified to Genus | | n | 1.67 | 1.04 | -- | -- | 0.4 |
| Total Identified to Family | | n | 1.33 | 4 | 4.8 | 0.28 | -- |

* Large taxa include values for count and weight, small taxa by counts alone.

Table 6.16. Density of Late Early Period Archaeobotanical Remains, Locus 2 (Strata 2h-3).

| **Stratum** | | | **2H** | **3A** | **3B** | **3C** | **3D** | **3E** |
|---|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | | **38-53** | **50-55** | **55-61** | **61-69** | **69-80** |
| **Feature** | | | **SF [1]** | | | | | |
| **Volume (liters)** | | | **0.50** | **3.75** | **0.75** | **2.50** | **2.25** | **5.25** |
| **Time Period** | | **/ L** | **Late Early Period** | | | | | |
| Scientific Name | Common Name | | | | | | | |
| Large Taxa | | | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | 0.53 | 2.67 | -- | 0.44 | -- |
| | | g | -- | 0.01 | 0.01 | -- | 0.002 | -- |
| *Brodiaea* s.l. | Brodiaea | n | 12 | 0.80 | 10.67 | -- | 5.78 | 4.57 |
| | | g | 0.08 | 0.003 | 0.03 | -- | 0.01 | 0.02 |
| *Marah* | Wild Cucumber | n | -- | 0.27 | -- | -- | 3.11 | 1.14 |
| | | g | -- | 0.001 | -- | -- | 0.01 | 0.002 |
| UnID Nutshell | | n | -- | -- | -- | -- | 1.78 | -- |
| | | g | -- | -- | -- | -- | 0.002 | -- |
| Wood Charcoal (2.0mm) | | g | 0.18 | 1.03 | 0.65 | 3.14 | 1.55 | 0.32 |
| Small Taxa | | | | | | | | |
| *Atriplex* spp. | Saltbush | n | -- | 0.27 | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | -- | 0.8 | 2.67 | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | 0.53 | -- | -- | -- | -- |
| *Poa* spp. | Blue Grass | n | -- | 0.27 | -- | -- | -- | -- |
| *Potamogeton* spp. | Pondweed | n | -- | 0.53 | -- | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | -- | 1.33 | 0.4 | -- | -- |
| Poaceae | Grass Family | n | -- | -- | 1.33 | -- | -- | 0.19 |
| Amorphous | | n | -- | 0.27 | 8 | -- | 2.22 | 1.14 |
| | | g | -- | 0.001 | 0.05 | -- | 0.004 | 0.01 |
| UnID Plant Tissue | | n | 6 | -- | -- | -- | -- | -- |
| | | g | 0.02 | -- | -- | -- | -- | -- |
| Centrospermae | | n | -- | 0.27 | -- | -- | -- | -- |
| Unidentified Seeds | | n | -- | -- | -- | -- | -- | -- |
| Unidentified Seed Fragments | | n | -- | -- | 1.33 | -- | -- | 0.19 |
| Total Identified to Genus | | n | -- | 2.4 | 2.67 | -- | -- | -- |
| Total Identified to Family | | n | -- | -- | 2.67 | 0.4 | -- | 0.19 |

[1]SF=Structure/Floor

Table. 6.17. Density of Late Period Archaeobotanical Remains, Locus 2 (Strata 1-2)

| **Stratum** | | | **1** | **2B-1** | **2B** |
|---|---|---|---|---|---|
| **Depth in cm** | | | **0-16** | | **16-36** |
| **Feature** | | | | **Pit** | **Pit** |
| **Volume (liters)** | | | **7.00** | **4.75** | **7.250** |
| **Time Period** | | **/L** | **Late Period** | | |
| Scientific Name | Common Name | | | | |
| Large Taxa | | | | | |
| *Arctostaphylos* spp. | Manzanita | n | 0.43 | 25.47 | 2.34 |
| | | g | 0.007 | 0.22 | 0.08 |
| *Brodiaea* s.l. | Brodiaea | n | 0.29 | 3.16 | 46.90 |
| | | g | 0.001 | 0.019 | 0.27 |
| *Marah* sp. | Wild Cucumber | n | 3 | 0.42 | 0.41 |
| | | g | 0.001 | 0.001 | 0.003 |
| *Quercus* spp. | Acorn Nutshell | n | 0.43 | 2.11 | 0.97 |
| | | g | 0.001 | 0.002 | 0.01 |
| UnID Nutshell | | n | -- | -- | 5.79 |
| | | g | -- | -- | 0.005 |
| Wood Charcoal | | g | 12.68 | 2.85 | 3.57 |
| Small Taxa | | | | | |
| *Achillea* sp. | Yarrow | n | -- | -- | 0.55 |
| *Atriplex* spp. | Saltbush | n | -- | -- | 1.38 |
| *Calandrinia* spp. | Red Maids | n | -- | -- | 3.31 |
| *Chenopodium* spp. | Goosefoot | n | -- | 5.47 | 1.1 |
| *Claytonia* spp. | Miners Lettuce | n | -- | -- | 0.55 |
| *Dendromecon* spp. | Bush Poppy | n | -- | -- | 0.83 |
| *Eriogonum* spp. | Buckwheat | n | -- | -- | 0.97 |
| *Hemizonia* spp. | Tarweed | n | -- | -- | 0.55 |
| *Lotus scoparius* | Deerweed | n | -- | 0.42 | -- |
| *Lepidium* spp. | Peppergrass | n | -- | -- | 0.55 |
| *Morella californica* | Wax Myrtle | n | -- | 0.63 | -- |
| *Phacelia* spp. | Phacelia | n | -- | 0.63 | 1.24 |
| *Potamogeton* spp. | Pondweed | n | -- | -- | 0.28 |
| *Silene* spp. | Catchfly | n | 1.14 | -- | -- |
| *Trifolium* spp. | Clover | n | -- | -- | 1.10 |
| Asteraceae | Sunflower Family | n | -- | 0.21 | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | 0.21 | 1.10 |
| Fabaceae | Bean Family | n | -- | -- | 0.28 |
| Poaceae | Grass Family | n | 1.14 | 0.63 | 14.9 |
| Amorphous | | n | -- | -- | 1.79 |
| | | g | -- | -- | 0.04 |
| UnID Plant Tissue | | n | -- | -- | 0.97 |
| | | g | -- | -- | 0.02 |
| Centrospermae | | n | -- | 0.63 | -- |
| Unidentified Seeds | | n | 0.57 | 3.58 | 7.31 |
| Unidentified Seed Fragments | | n | 0.57 | 2.32 | 9.1 |
| Total Identified to Genus | | n | 1.14 | 7.16 | 12.41 |
| Total Identified to Family | | n | 1.14 | 1.05 | 16.28 |

* Large taxa include values for count and weight, small taxa by counts alone.

Table 6.18. Density of Early Period Archaeobotanical Remains, Locus 3 (Strata 9-12).

| **Stratum** | | | **9** | **10A** | **10B** | **11** | **12** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **112-120** | **120-125** | **125-132** | **132-149** | **149-166** |
| **Volume (liters)** | | | **4.75** | **2.25** | **4.00** | **4.50** | **6.00** |
| **Time Period** | | | **Early Period** | | | | |
| Scientific Name | Common Name | | | | | | |
| Large Taxa | | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | 0.44 | -- | -- | -- |
| | | g | -- | 0.002 | -- | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 1.68 | 9.33 | 10.5 | 4.22 | 3.33 |
| | | g | 0.004 | 0.018 | 0.03 | 0.01 | 0.01 |
| *Marah* | Wild Cucumber | n | -- | -- | 1.0 | 0.22 | 0.17 |
| | | g | -- | -- | 0.003 | 0.001 | 0.001 |
| *Quercus* | Acorn | n | -- | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- | -- |
| UnID Nutshell | | n | -- | -- | -- | 0.44 | -- |
| | | g | -- | -- | -- | 0.001 | -- |
| Wood Charcoal | | g | 0.06 | 0.24 | 0.65 | 0.14 | 0.16 |
| Small Taxa | | | | | | | |
| *Euphorbia* spp. | Spurge | n | 0.21 | -- | -- | -- | -- |
| *Heliotropium* sp. | Sea Heliotrope | n | -- | -- | -- | -- | 0.17 |
| *Hypericum* spp. | Tinker's Penny | n | -- | -- | -- | -- | 0.17 |
| *Rhus integrifolia* | Lemonade Berry | n | -- | -- | -- | -- | 0.17 |
| *Trifolium* spp. | Clover | n | -- | -- | -- | -- | 0.17 |
| Fabaceae | Bean Family | n | -- | -- | -- | 0.44 | -- |
| Poaceae | Grass Family | n | -- | 0.44 | 0.25 | -- | -- |
| Solanaceae | Nightshade Family | n | 0.21 | -- | -- | -- | -- |
| Amorphous | | n | -- | 0.89 | -- | -- | -- |
| | | g | -- | 0.002 | -- | -- | -- |
| Centrospermae | | n | 0.21 | -- | -- | -- | -- |
| Unidentified Seeds | | n | 0.42 | -- | -- | 0.67 | 1.5 |
| Unidentified Seed Fragments | | n | -- | 4.44 | -- | -- | 1.67 |
| Total Identified to Genus | | n | 0.21 | -- | -- | -- | 0.67 |
| Total Identified to Family | | n | 0.21 | 0.44 | 0.25 | 0.44 | -- |

* Large taxa include values for count and weight, small taxa by counts alone.

Table 6.19. Density of Late Early Period Archaeobotanical Remains, Locus 3 (Strata 5-8).

| **Stratum** | | | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|
| **Depth in cm** | | | **60-71** | **71-83** | **83-87** | **87-112** |
| **Volume (liters)** | | | **4.00** | **5.00** | **1.75** | **5.75** |
| **Time Period** | | **/L** | **Late Early Period** | | | |
| Scientific Name | Common Name | | | | | |
| Large Taxa | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 2.0 | 10.6 | 5.71 | 3.65 |
| | | g | 0.005 | 0.04 | 0.03 | 0.02 |
| *Marah* | Wild Cucumber | n | 0.5 | 3.2 | 1.71 | 1.39 |
| | | g | 0.003 | 0.008 | 0.003 | 0.003 |
| *Quercus* | Acorn | n | -- | 0.4 | -- | -- |
| | | g | -- | 0.001 | -- | -- |
| UnID Nutshell | | n | 0.25 | -- | 1.14 | 0.87 |
| | | g | 0.001 | -- | 0.003 | 0.002 |
| Wood Charcoal | | g | 2.06 | 2.43 | 0.49 | 0.53 |
| Small Taxa | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | -- | -- | -- |
| *Aphanes occidentalis* | Lady's Mantle | n | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | 0.5 | -- | -- | -- |
| *Chenopodium* spp. | Goosefoot | n | -- | 0.2 | -- | 0.17 |
| *Euphorbia* spp. | Spurge | n | -- | -- | -- | -- |
| *Galium* spp. | Bedstraw | n | -- | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | -- | -- | -- |
| *Phalaris* spp. | Canary Grass | n | -- | 0.2 | 0.57 | -- |
| *Poa* spp. | Blue Grass | n | 0.25 | -- | -- | -- |
| *Potamogeton* spp. | Pondweed | n | -- | -- | -- | -- |
| *Salvia* spp. | Chia, Sage | n | -- | -- | -- | 0.17 |
| Chenopodiaceae | Goosefoot Family | n | -- | -- | 0.57 | -- |
| Fabaceae | Bean Family | n | -- | -- | -- | 0.17 |
| Malvaceae | Mallow Family | n | -- | 0.2 | -- | -- |
| Poaceae | Grass Family | n | 0.25 | -- | -- | -- |
| Amorphous | | n | 0.5 | -- | -- | -- |
| | | g | 0.001 | -- | -- | -- |
| Centrospermae | | n | -- | -- | 0.57 | -- |
| Unidentified Seeds | | n | 3 | 1.2 | -- | 0.7 |
| Unidentified Seed Fragments | | n | 1.75 | 0.6 | -- | -- |
| Total Identified to Genus | | n | 0.75 | 0.4 | 0.57 | 0.35 |
| Total Identified to Family | | n | 0.25 | 0.2 | 0.57 | 0.17 |

* Large taxa include values for count and weight, small taxa by counts alone.

Table 6.19 (cont.). Density of Middle and Late Early Period Archaeobotanical Remains, Locus 3 (Strata 2-4).

| **Stratum** | | | **3** | **3** | **4** | **2** |
|---|---|---|---|---|---|---|
| **Depth in cm** | | | **43-49** | **49-60** | **45-60** | **34-43** |
| **Volume (liters)** | | | **3.25** | **4.75** | **0.75** | **3.50** |
| **Time Period** | | **/L** | **Late Early** | | | **Middle** |
| Scientific Name | Common Name | | | | | |
| Large Taxa | | | | | | |
| *Arctostaphylos* spp. | Manzanita | n | 0.31 | 0.21 | -- | -- |
| | | g | 0.002 | 0.002 | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 5.54 | 9.26 | 24.0 | 0.29 |
| | | g | 0.05 | 0.03 | 0.01 | 0.006 |
| *Marah* | Wild Cucumber | n | 0.92 | 3.16 | 2.67 | 0.29 |
| | | g | 0.002 | 0.006 | 0.007 | 0.003 |
| *Quercus* | Acorn | n | 3.69 | 1.47 | -- | -- |
| | | g | 0.003 | 0.001 | -- | -- |
| UnID Nutshell | | n | -- | 0.21 | -- | -- |
| | | g | -- | 0.001 | -- | -- |
| Wood Charcoal | | g | 1.48 | 1.91 | 2.49 | 1.04 |
| Small Taxa | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | -- | 1.33 | -- |
| *Aphanes occidentalis* | Lady's Mantle | n | 0.62 | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | -- | 1.9 | -- | 0.57 |
| *Chenopodium* spp. | Goosefoot | n | -- | -- | -- | -- |
| *Claytonia* spp. | Miner's Lettuce | n | -- | -- | -- | 0.57 |
| *Euphorbia* spp. | Spurge | n | 0.31 | -- | -- | -- |
| *Galium* spp. | Bedstraw | n | -- | 0.21 | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | 0.21 | 1.33 | -- |
| *Phalaris* spp. | Canary Grass | n | -- | 0.63 | -- | 0.57 |
| *Poa* spp. | Blue Grass | n | -- | -- | -- | -- |
| *Potamogeton* spp. | Pondweed | n | 0.31 | -- | -- | -- |
| *Salvia* spp. | Chia, Sage | n | -- | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | 1.54 | 1.68 | -- | 11.71 |
| Fabaceae | Bean Family | n | -- | -- | -- | -- |
| Malvaceae | Mallow Family | n | -- | -- | -- | -- |
| Poaceae | Grass Family | n | 0.62 | 0.42 | -- | 3.43 |
| Amorphous | | n | 0.92 | 2.32 | 45.33 | 1.43 |
| | | g | 0.002 | 0.001 | 0.03 | 0.01 |
| Centrospermae | | n | -- | -- | -- | 5.71 |
| Unidentified Seeds | | n | 0.92 | 0.21 | -- | 1.33 |
| Unidentified Seed Fragments | | n | 3.39 | 5.47 | -- | -- |
| Total Identified to Genus | | n | 1.23 | 2.95 | -- | 2.67 |
| Total Identified to Family | | n | 2.15 | 2.11 | -- | -- |

* Large taxa include values for count and weight, small taxa by counts alone.

Table 6.20. Density of Late/Transitional Period Archaeobotanical Remains, Locus 3 (Strata1-1A)

| **Stratum** | | | **1** | **1** | **1** | **1A** |
|---|---|---|---|---|---|---|
| **Depth in cm** | | | **0-17** | **14-24** | **24-34** | **16-27** |
| **Volume (liters)** | | | **6.00** | **2.00** | **4.00** | **1.25** |
| **Time Period** | | **/L** | **Late/Transitional** | | | |
| Scientific Name | Common Name | | | | | |
| Large Taxa | | | | | | |
| *Arctostaphylos* | Manzanita | n | 0.17 | -- | -- | 0.8 |
| | | g | 0.001 | -- | -- | 0.004 |
| *Brodiaea* s.l. | Brodiaea | n | 0.5 | 0.5 | 6.0 | 6.4 |
| | | g | 0.05 | 0.003 | 0.02 | 0.07 |
| *Marah* | Wild Cucumber | n | 0.67 | -- | 1.25 | -- |
| | | g | 0.002 | -- | 0.003 | -- |
| *Quercus* | Acorn | n | 3.67 | 1.0 | 0.5 | 2.4 |
| | | g | 0.003 | 0.005 | 0.001 | 0.004 |
| Wood Charcoal | | g | 0.57 | 0.88 | 1.63 | 0.38 |
| Small Taxa | | | | | | |
| *Bromus* spp. | Brome Grass | n | -- | -- | -- | 1.6 |
| *Claytonia* sp. | Miner's Lettuce | n | 0.67 | -- | -- | -- |
| *Phalaris* spp. | Canary Grass | n | -- | -- | -- | 0.8 |
| *Sambucus* sp. | Elderberry | n | -- | -- | 0.5 | -- |
| *Silene* spp. | Catchfly | n | 2.67 | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | 2.0 | 1.0 | 1.5 | 0.8 |
| Fabaceae | Bean Family | n | -- | -- | -- | 0.8 |
| Poaceae | Grass Family | n | 0.67 | 1.0 | 0.5 | 0.8 |
| Amorphous | | n | 3.0 | -- | 1.0 | -- |
| | | g | 0.005 | -- | 0.003 | -- |
| Centrospermae | | n | 0.67 | -- | 0.25 | -- |
| Unidentified Seeds | | n | 8.67 | 0.5 | 0.25 | 3.2 |
| Unidentified Seed Fragments | | n | 0.17 | 1 | 2 | 3.2 |
| Total Identified to Genus | | n | 3.33 | -- | 0.5 | 0.5 |
| Total Identified to Family | | n | 2.67 | 2 | 2 | 2 |

* Large taxa include values for count and weight, small taxa by counts alone.

A variety of plant remains that can be used for food, medicine, and/or tools were identified at the Diablo Valdez site. The ethnographic use of these plants, quantitative analysis, and their significance during nearly 6,000 years of occupation is presented in Chapter 7. The plant remains alone identified at Diablo Valdez are remarkable in their

abundance and diversity, highlighting the potential importance of geophytes in island subsistence regimes.

The spectacular domestic features identified during excavation suggest that people were living at this site for longer periods of time than for simply procuring seasonal plant resources. The two Early Period roasting pits, the Late Early Period structure, and the Late Period hearth clearing pit features, human burials, and house depressions indicate that the pattern of intensive and consistent inhabitation of the site persisted for nearly 6,000 years. The Middle Period is less well represented than either earlier or later in time, and no distinctive features dating to this period have yet been identified, but additional investigation at the site may elucidate occupation patterns during this period.

The abundance of faunal remains—primarily from marine resources—indirectly illustrates the importance of interior resources at this location, such as plants, fresh water, fuel, etc. The artifact assemblage is consistent with other island sites, although artifacts (including beads and bead detritus) are not particularly abundant. Rather, the primary focus of activity at this site during all time periods appears to be subsistence related, an idea supported by surface finds of bowl mortars, doughnut stone fragments, and artifacts associated with groundstone manufacture/maintenance. Collectively, the Diablo Valdez site appears to have been a place where Islanders lived, ate, and used both marine and terrestrial resources for nearly 6,000 years.

# CHAPTER 7

# A CRITICAL EVALUATION OF TERRESTRIAL PLANT USE THROUGH TIME ON SANTA CRUZ ISLAND

In this chapter, I critically evaluate the use of plants over the last 6,000 years on Santa Cruz Island using the paleoethnobotanical data from the Brodiaea Ridge, Sunburst, and Diablo Valdez sites. First, I discuss how these plants were used in prehistoric California based on available ethnobotanical data, and specifically Chumash ethnobotany whenever possible. I then present quantitative analyses comparing plant types, habitat types, season of occupation, and the ubiquity, diversity and equitability among the samples collected. I also present an independent assessment of various taxa densities and ratios to total plant weight through time. Finally, I use these data to evaluate the proposed revised plant food rankings based on carbohydrates and seasonal availability presented in Chapter 3.

## Ethnobotanical Uses of Identified Plants from all Sites

The paleoethnobotanical remains identified during my project represent 37 different plants used for food, medicine, raw materials, and fuel. Chumash informants described many of these ethnohistoric uses, but other sources from California were also consulted in this discussion (see also Appendix A). Only two identified taxa have no known ethnobotanical use and are discussed separately. Food plants are grouped by plant type (see Chapter 3), excluding aquatic roots/rhizomes, as none were identified during this project. Table 7.1 summarizes the ethnohistorical uses for the plants identified and described in the text, in terms of whether they were used for food, medicine, and/or tools. Tools made of plant

materials include construction materials, digging sticks, etc., but fuel sources are not included. Various plants could have been used for fuel, but wood charcoal identification was not undertaken. A total of 27 food plants was identified during this project, only 15 of which have been documented in the Chumash ethnohistoric record. Nineteen plants with medicinal uses were identified, nine of which were recorded among the Chumash. Eleven plants used to make various tools were identified, nine of which have a known Chumash use. These discrepancies between known Chumash uses and the larger ethnohistoric record on the one hand, and the identified remains in the archaeobotanical record on the other, highlight how much information about native uses of plants is missing from the ethnohistoric record for the Chumash.

*Plants Used for Food*

The food plants and their ethnobotanical uses presented here are grouped by plant category types described in Chapter 3. Kelps and seaweeds are not included, as no direct evidence for their use was identified in the project's archaeobotanical assemblage. Because leafy greens and stems rarely preserve in the record, and are instead largely represented by their seeds (which are often also eaten), discussion of them is included with the small seeds.

Geophytes. The ethnographic use of geophytes, and brodiaea corms in particular, was discussed in detail in Chapter 3. Fresh brodiaea corms can be eaten raw or roasted in large roasting pits. Brodiaea corms were reportedly an important plant food on the islands, and they could have been harvested during multiple seasons (see below).

Table 7.1. Summary of Ethnohistoric Uses for Identified Botanical Remains

| | | Use | | |
|---|---|---|---|---|
| **Common Name** | **Genus** | **Food** | **Medicine** | **Tool** |
| Bedstraw | *Galium* | | X | |
| Bladderpod | *Peritoma* | X | | |
| Blue Eyed Grass | *Sisyrinchium* | | X | |
| Blue Grass | *Poa* | X | | |
| Brodiaea | *Brodiaea* | X[1] | | |
| Brome Grass | *Bromus* | X | | |
| Buckwheat | *Eriogonum* | X | X[1] | |
| Bush Poppy | *Dendromecon* | X | | |
| Canary Grass | *Phalaris* | X | | |
| Catchfly | *Silene* | | X[1] | |
| Chamise | *Adenostoma* | | | X[1] |
| Clover | *Trifolium* | X[1] | | |
| Deerweed | *Lotus* | | | X[1] |
| Elderberry | *Sambucus* | X[1] | X[1] | X[1] |
| Goosefoot | *Chenopodium* | X[1] | | |
| Island barberry | *Berberis* | X | X | X |
| Lemonade berry | *Rhus* | X[1] | | |
| Manzanita | *Arctostaphylos* | X[1] | X | X[1] |
| Miner's Lettuce | *Claytonia* | X[1] | | |
| Oak | *Quercus* | X[1] | | X[1] |
| Peppergrass | *Lepidium* | X[1] | X[1] | |
| Phacelia | *Phacelia* | X | X | |
| Pine | *Pinus* | X[1] | | X[1] |
| Pondweed | *Potomogeton* | X | | |
| Red Maids | *Calandrinia* | X[1] | | |
| Sage | *Salvia* | X[1] | X[1] | X[1] |
| Saltbush | *Atriplex* | X | X[1] | |
| Seaside Heliotrope | *Heliotropum* | X | X | |
| Spikerush | *Eleocharis* | X | X | |
| Spurge | *Euphorbia* | | X[1] | |
| Tarweed | *Hemizonia/Madia* | X[1] | | X |
| Toyon | *Heteromeles* | X[1] | X | X[1] |
| Tinker's Penny | *Hypericum* | | X | |
| Wax Myrtle | *Morella* | | X | |
| Wild Cherry | *Prunus* | X[1] | | |
| Wild Cucumber | *Marah* | | X[1] | X[1] |
| Yarrow | *Achillea* | | X[1] | |
| **Total Chumash Uses** | | **15** | **9** | **9** |
| **Total Native California Uses** | | **27** | **19** | **11** |

Notes: [1]Ethnohistorically recorded Chumash use (Timbrook 2007). Other uses compiled from Anderson 2005, Mead 2003, Timbrook 2007, and as noted in the text.

As I noted in Chapter 2, brodiaea and especially blue dicks are now phenomenally abundant on the island, occurring mainly in grassland habitats. This post-ranching era recovery is consistent with Chumash accounts of their dietary significance.

Fruits, Berries, and Pits. Manzanita berries (*Arctostaphylos* spp.) ripen in the summer and contain large segmented pits within a dry pulpy fruit. They were considered an important food source for the Chumash and other groups in California as well, given their high carbohydrate content (Gilliland 1985; Mead 2003; Timbrook 2007). The whole berries were ground into flour, winnowed, and eaten as a coarse mush or pinole (Timbrook 2007:34). Lemonade berry (*Rhus integrifolia*) is common on the islands and produces an edible fruit containing a large edible seed. The outside fruit is thin and sticky and tastes like tart lemonade. The Chumash processed lemonade berry by pounding the entire fruit, drying it, and eating it without cooking (Timbrook 2007:166). The berries of elderberry (*Sambucus* sp.) ripen in the summer and were commonly used throughout California, eaten fresh or cooked. Toyon berries (*Heteromeles* sp.) mature in the winter and were also collected for food. Island barberry (*Berberis* sp.) has no recorded Chumash use but was used by various native groups as food, medicine, and yellow dye. The Yana ate the berries, pounded and mixed with water to form a mush, although other groups considered the berries poisonous in large amounts. The roots were boiled and drunk as a tea for a variety of ailments, and a poultice of chewed leaves/roots was used to treat wounds. A bright yellow dye was made from the bark and roots by a variety of groups as well (Mead 2003).

Small Seeds, Leafy Greens, and Stems. A variety of small seeds was recovered throughout the sampled deposits, indicating their importance in the Island Chumash diet. Saltbush (*Atriplex* spp.) and goosefoot (*Chenopodium* spp.) are both in the Goosefoot Family

(Chenopodiaceae) and produce edible seeds. Although plant cultivation is not known to have existed in California (except for the Owens Valley Paiute), seeds of the cheno-ams (Chenopodiaceae and Amaranthaceae) were cultivated in other regions including the southeastern and southwestern United States, Mexico, and South America, as well as in the Old World. Red maids (*Calandrinia* spp.) seeds were a nutritious and important food, considered one of the most valued foods among the Chumash. They were also used in ritual offerings, including burials, and have been found archaeologically on the islands and adjacent mainland as well (Timbrook 2007:46-48). The seeds of miner's lettuce (*Claytonia* sp.) were a traditional food, although the leaves are edible as well, eaten either raw or cooked (Timbrook 2007:58). The greens of various species of clover (*Trifolium* spp.) were eaten in the spring, and the seeds were eaten as well (Timbrook 2007:219). The ethnographic use of seaside heliotrope (*Heliotropium curassavicum*) was not recorded among the Chumash, but their seeds were used widely throughout California as food, ground into a pinole (Mead 2003). Bladderpod (*Peritoma* spp., formerly *Isomeris* spp.) has no known Chumash use, but the flowers and pods were eaten by the Kawaiisu and Cahuilla, respectively (Mead 2003:212). Phacelia (*Phacelia* spp.) leaves and stems are also edible. Although not recorded for the Chumash, the Luiseño and Kawaiisu ate them fresh in the spring (Anderson 2005; Mead 2003; Zigmond 1981).

Buckwheat (*Eriogonum* spp.) seeds are small but edible, and a variety of native species occur and are abundant on the islands and adjacent mainland. The large Santa Cruz Island buckwheat (*E. arborescens*) shrub produces many flower heads per plant, and many seeds could be collected from a single plant at one time (Mead 2003). Tarweed (*Hemizonia* sp. and *Madia* sp.) seeds were typically winnowed, pounded with a mortar and pestle, mixed

with a small amount of water to form a ball, and eaten raw by the Chumash (Timbrook 2007:90). The seeds of peppergrass (*Lepidium* sp.) were toasted and ground into a pinole as food. The seeds of sage (*Salvia* spp.) are edible, and the seeds of chia (*S. columbariae*) were particularly prized by the Chumash, although other species of sage were probably eaten as well. The seeds were collected in late spring and summer and often stored. Preparing chia involved toasting the seeds, grinding them into a fine flour and mixing it with cold water until the pinole thickened to the desired texture (Timbrook 2007:188-190). The use of bush poppy seeds for food is not documented in the Chumash region, yet they were eaten by the Kawaiisu (Mead 2003; Zigmond 1981).

As with most seeds of the grass family (Poaceae), the seeds of blue grass (*Poa* spp.), brome grass (*Bromus* spp.), and canary grass (*Phalaris* spp.) are edible and were likely used as food by the Chumash. Both blue and brome grass occur on the islands and adjacent mainland today. Although there are four species of canary grass that occur on Santa Cruz Island today, none are native to California (Junak et al. 1995). Two species native to California (*P. californica* and *P. lemmonii*) occur on the mainland and Santa Rosa Island, but are not known to occur on Santa Cruz Island today. Canary grass may be an example of native flora that was extirpated from the island during the historic ranching period, although it is also possible that small populations do occur on the island but have not yet been identified. Pondweed (*Potamogeton* spp.) is an aquatic taxon, occurring in coastal salt marsh, freshwater wetland or wetland-riparian habitat. According to Junak et al. (2005:317), the entire plant of pondweed is edible, including the seeds.

Non-Toxic Nuts. Although evidence for the use of pine nuts (technically seeds) was not found in the light fraction samples, a single large pine nut was recovered from the

screened material at Diablo Valdez, locus 3 (see Chapter 6). Pine nuts are an important food in many areas of California (Gamble and Mattingly 2012; Timbrook 2007), but there is no evidence that they were particularly important on the Channel Islands.

Toxic Nuts. Acorn (*Quercus* spp.) was documented ethnographically as an important food source in native California. Acorns were collected in the fall and had to be leached prior to cooking to remove toxic tannic acids. Ten different species (and an additional subspecies) of oak are found on Santa Cruz Island and are abundant in certain areas of the island. The pits of wild cherry were an important and ethnohistorically documented food among the Chumash that, like acorn, had to be leached prior to cooking to remove toxic cyanic acids. Because processing both acorns and wild cherry pits was relatively laborious (McCarthy 1993), these toxic nuts and pits are typically ranked lower than other food sources with comparable nutritional properties (Wohlgemuth 2010; see Chapter 3). The importance of wild cherry pits and especially acorns to island populations has been debated in the literature, with previous paleoethnobotanical evidence indicating consistent use through time but not as a particularly important food (Gill and Erlandson 2014; see Chapter 3).

*Plants Used for Medicine, Raw Materials, and Fuel*

Although some species of spikerush (*Eleocharis* sp.) produce an edible corm, its seeds were recovered here, suggesting a different use. In Hawaii, spikerush stems were used in weaving and as a medicine for its antibiotic properties (Tava and Keale 1990). Yarrow (*Achillea melllifolium*) was used medicinally as a poultice for the treatment of cuts and wounds, as it helps to stop bleeding and acts as a pain reliever (Timbrook 2007:22).

Bedstraw (*Galium* spp.) has no recorded Chumash use but was used medicinally by various native California groups. The southern Maidu used the leaves and stems as a treatment for rheumatism, the Miwok took it as a tea for the treatment of edema, and Karok women made a "love medicine" from bedstraw (Mead 2003). Many plants of the spurge genus (*Euphorbia* spp.) are considered poisonous, but they were used medicinally by various groups in California, largely as a cure for rattlesnake bites (Mead 2003). Tinker's penny, also known as St. John's Wort (*Hypericum* spp.), was used medicinally as an anti-inflammatory and antibiotic by various groups in California (Mead 2003). Catchfly (*Silene* spp.), called "hummingbird sucks it" by the Chumash, was drunk as a medicinal tea for birth control. Timbrook (2007:210) states that "women would boil this plant and drink the tea to make their menses flow, and they would take it with wine if they did not want to become pregnant." Blue-eyed grass (*Sisyrinchium bellum*) was used medicinally in California for various purposes (Mead 2003), yet it has no recorded use among the Chumash. It does, however, have a Chumash name, *sh'ichk 'i'waqaq*, meaning "frog's g-string," which suggests it had a prehistoric Chumash use (Timbrook 2007:211).

Elderberry flowers were used medicinally for a variety of ailments, including wounds, fever, colds and sunstroke. The leaves, stems and roots of buckwheat were used medicinally for the treatment of colds, coughs and blood purification (Timbrook 2007:84). The pinole or a boiled leaf of peppergrass (*Lepidium* sp.) was used as a treatment for diarrhea and dysentery, and the Spanish name for the plant, *Tapona*, means "plug" (Timbrook 2007:111). The Chumash did not indicate the seeds of buckwheat were eaten, but rather the leaves and flowers were used medicinally, drunk as a tea to stop hemorrhages, as a blood purifier, and for stomach problems (Timbrook 2007:84-85). Little ethnographic information exists for the

use of phacelia in California, although the seeds are often found in island archaeobotanical assemblages (Gill 2013). Phacelia leaves were used medicinally as a poultice for sores and wounds or drunk as a tea for colds and coughs (Mead 2003; Zigmond 1981). Seaside heliotrope roots were also boiled into a medicinal tea to treat diarrhea (Mead 2003; Junak et al. 1995). Wild cucumber (*Marah* sp.) is commonly found in archaeological sites throughout California, including the islands, but is not an edible plant. Rather, the oily poisonous seeds were ground into a paste to use as a pigment binder or as a salve for the treatment of baldness (Martin 2010; Timbrook 2007). The seeds were also sometimes strung as beads, and the spiny fruit capsule was used as a container for the powerful supernatural mixture *'ayip* (Timbrook 2007). The bark of manzanita (*Arctostaphylos* spp.) was used by various groups in California as a tea for stomach problems, but its use was not recorded among the Chumash (Mead 2003).

California wax myrtle (*Morella californica*, previously *Myrica californica*) was not mentioned in Harrington's ethnographic notes on Chumash ethnobotany, and there is little ethnographic evidence for its use in California generally. However, various species and native uses occur throughout North America, including the Southeast, where southern wax myrtle (*Myrica cerifera*) was commonly used for a variety of purposes. The fragrant leaves and seeds were used as a spice for flavoring foods, and the waxy fruit was boiled down to extract wax for insect-repellent smokeless candles. A tea made from the bark was also used to treat a variety of ailments, including dysentery, inflammation, and headache, and it was even used as a vermifuge (to expel intestinal worms and parasites). The leaves were also used as a substitute for tobacco or mixed with tobacco to make supplies last longer (Austin 2004:767-769). As with other species of wax myrtle, the California wax myrtle has similar

properties, although the wax content of the fruit is lower than in other species, making it more difficult to render wax from the fruit (UC Agriculture and Natural Resources 2014). The presence of California wax myrtle in the Late Period deposits at Diablo Valdez is interesting, as wax myrtle does not grow on the northern Channel Islands today. However, it was noted as occurring on Santa Cruz Island by Chaney and Mason (1930) and Raven (1965) during the Pleistocene. Its current range extends along the coastal areas of California, primarily north of Point Conception, although herbarium specimens are known from as far south as the Santa Monica Mountains. That wax myrtle persisted as a Pleistocene relic as far south as the Santa Monica Mountains suggests it also could have persisted in some locations on Santa Cruz Island, possibly until extirpation during the historical ranching period, when sheep severely overgrazed the islands. Alternatively, it is possible that wax myrtle was extirpated from Santa Cruz Island earlier in prehistoric times and traded to people occupying the Diablo Valdez site from the mainland coast near Point Conception or from further south nearer the Santa Monica Mountains.

Deerweed (*Lotus scoparius*), also known as California Broom, was used to make brooms for sweeping out the mission ovens as well as sweeping outside. It was also used for thatching sweathouses, as it reportedly did not burn easily (Timbrook 2007:117-118). Tarweed plants were also used to make brooms for sweeping (Timbrook 2007:90). Although the seeds are not known to be edible, the hard wood of chamise (*Adenostoma* spp.) was important in tool making (e.g., arrow foreshafts, clam digging sticks), and the leaves were considered medicinal for childbirth and menstrual issues (Hudson and Blackburn 1982:253-254; Timbrook 2007:22-23). Its use as a fuel source may help explain the presence of carbonized chamise seeds in these samples. The wood of elderberry was also important for a

variety of purposes, including as a container for tobacco, firesticks, and musical instruments such as flutes, clappersticks, and bullroarers (Timbrook 2007:195-198). The wood of manzanita (*Arctostaphylos* spp.) was used among the Chumash to smoke fish (Timbrook 2007:34).

*Plants with Unknown Ethnobotanical Use*

Only two genera were identified that have no known ethnobotanical use: lady's mantle (*Aphanes occidentalis*) and ditchgrass (*Ruppia* sp.). Lady's mantle is a grassland species, whereas ditchgrass occurs in coastal salt marsh, freshwater wetland, and wetland-riparian habitats. These taxa may have been used for a purpose undocumented in ethnohistoric literature, or they may have been transported to the site incidentally as riders on people and/or animals.

## Comparative Analysis of the Archaeobotanical Data

### Relative Abundance

*Plant Food Types*

Comparing the relative proportions of plant food types (i.e., geophytes, non-toxic pits, toxic nuts/pits, and small seeds) through time is useful for interpreting temporal changes in diet breadth and site use. In this analysis, count data were used, with feature data and those plants used strictly for medicinal or tool purposes excluded. The relative proportions of plant types, then, show the variation in plant food use through time from general midden deposits. Table 7.2 presents the relative proportions of food plant types identified at each site, and time period. Plant types from Early, Late Early, Middle and Late Period deposits are represented

at the Diablo Valdez site, while the Sunburst site includes Late Period deposits only. Data from the Brodiaea Ridge site are presented as well, although the mixed deposits at this site represent around 6,000 years of occupation and cannot be directly compared with assemblages from one time period or another represented at the other sites.

Table 7.2. Relative Proportion (%) of Plant Food Types at Each Site

| | **Diablo Valdez** | | | | **Sunburst** | **Brodiaea Ridge** |
|---|---|---|---|---|---|---|
| | *Early* | *Late Early* | *Middle* | *Late* | *Late* | *Early-Late* |
| *Geophytes* | 75.3 | 75.4 | 46.2 | 21.3 | 7.4 | 35.2 |
| *Small Seeds* | 18.3 | 19.0 | 20.5 | 57.4 | 54.7 | 54.4 |
| *Non-Toxic Pits* | 4.1 | 2.2 | 2.6 | 2.7 | 30.5 | 3.8 |
| *Toxic Nuts/Pits* | 2.3 | 3.4 | 30.8 | 17.5 | 7.4 | 5.7 |
| *Fruits* | -- | -- | -- | 1.1 | -- | 0.9 |

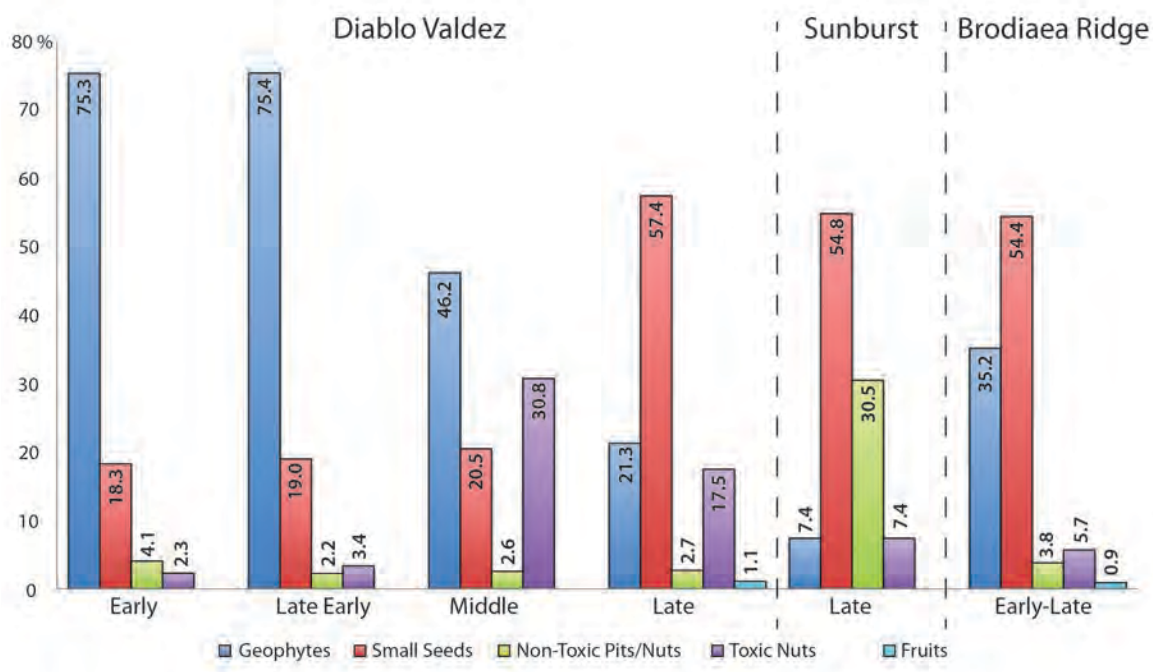


Figure 7.1. Relative Proportion (%) of Plant Food Types at Each Site

The relative proportions of plant types at the Diablo Valdez site show that geophytes dominate the Early and Late Early assemblages compared to small seeds, non-toxic pits, and toxic nuts. During the Middle Period, toxic nuts (acorn nutshell) increase proportionately to geophytes, while small seeds and non-toxic pits remain proportionately similar to earlier time periods. Small seeds increase in abundance relative to other plant foods in the Late Period, while geophytes and toxic nuts are ~21% and 17% of the assemblage, respectively. Of importance, data from the Middle Period are from a single sample and should be interpreted with caution. Nevertheless, the increase in acorn nutshell and small seeds during the Middle and Late Periods at Diablo Valdez appears to indicate a shift in the plant food diet from geophytes to acorn and small seeds. The significance of this shift is explored in more detail later in this chapter, using both density and standardized ratios to examine change through time for each plant type independently of the others.

The relative proportions of plant types at the Late Period Sunburst site indicate that small seeds (55%) and non-toxic pits (31%) dominate the plant foods, with smaller proportions of geophytes and toxic nuts (~7% each) present. The non-toxic pits are composed predominately of manzanita berry pits, with some lemonade berry as well, whereas acorn nutshell makes up the toxic nut category. Compared with the Late Period assemblage at Diablo Valdez, the Sunburst plant types show a similar emphasis on small seeds (>55%), although non-toxic pits are more abundant at Sunburst than in any other of the site assemblages, regardless of time period.

While the mixed deposits at Brodiaea Ridge limit our ability to assess plant use through time, the assemblage as a whole indicates the importance of small seeds (54%) and

geophytes (35%) at this location. Both toxic and non-toxic nuts/pits were used at this site, but they occur in relatively low proportions in the assemblage.

*Small Seeds*

The relative proportions of all plant food remains at Diablo Valdez and Sunburst suggest that small seeds were more abundant relative to other plant food types during the Late Period, while small seeds composed ~20% of the plant foods earlier in time at Diablo Valdez. An examination of the dominant taxa within the small seed category is important for evaluating diversity and changes in the use of small seeds at these sites through time. Table 7.3 presents the relative proportions of the dominant (>30%) small seed taxa present at Diablo Valdez and Sunburst (see Figure 7.2).

While the seeds of cheno-ams and grasses are more abundant than any other single taxon at Diablo Valdez in the Early Period strata, ~38% of the small seeds include various other taxa, indicating a relatively diverse small seed assemblage. The relative proportion of cheno-ams and grasses remains largely the same in the Late Early Period, although red maids are proportionately the most abundant small seed taxon (~31%) during this time. During the Middle and Late Periods, however, cheno-ams and grasses dominate the small seed assemblages, making up ~88 and 91% of the total small seeds, respectively.

Table 7.3. Relative Proportion (%) of Small Seed Taxa at Diablo Valdez and Sunburst

| | **Diablo Valdez** | | | | **Sunburst** |
|---|---|---|---|---|---|
| | *Early* | *Late Early* | *Middle* | *Late* | *Late* |
| *Cheno-Ams* | 33.3 | 27.5 | 62.5 | 59.0 | 4.5 |
| *Grasses* | 25.0 | 23.5 | 25.0 | 32.4 | 9.0 |
| *Red Maids* | 2.8 | 31.4 | -- | 1.9 | -- |
| *Sage* | 1.4 | 2.0 | -- | -- | 40.5 |
| *Other* | 37.5 | 15.7 | 12.5 | 6.7 | 46.0 |

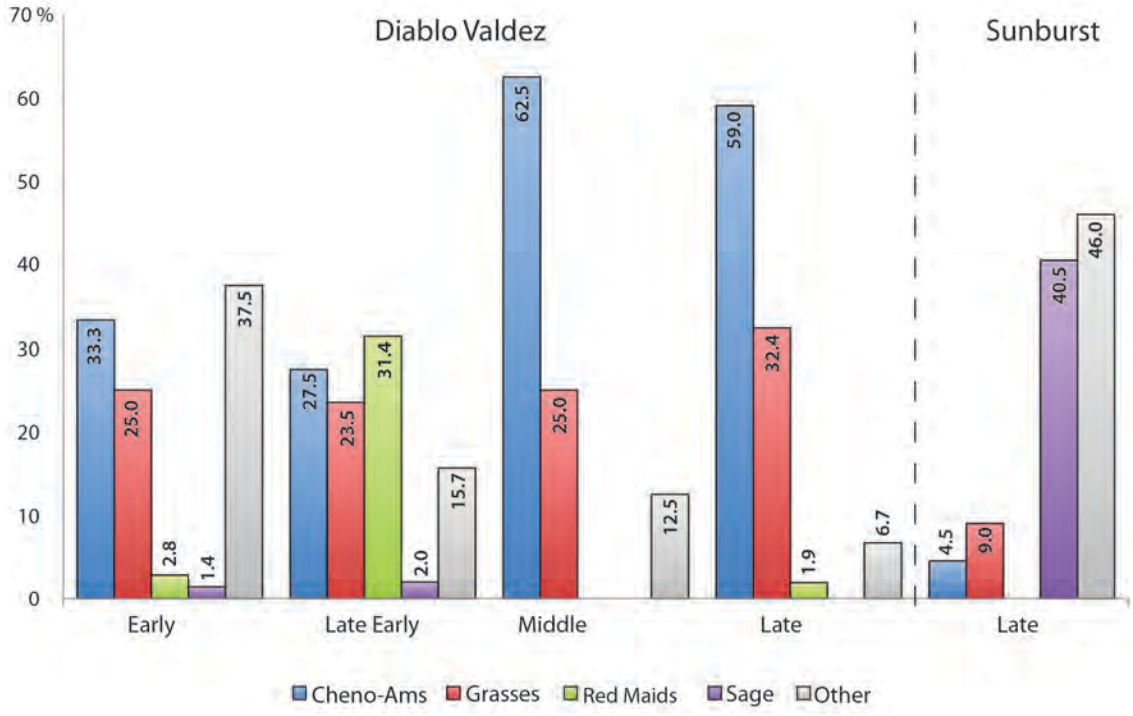


Figure 7.2. Relative Proportion of Small Seed Taxa at Diablo Valdez and Sunburst

The small seed assemblage at the Sunburst site looks quite different from the Diablo Valdez Late Period deposits, with sage seeds the single most dominant taxon at ~41%. While the sage seeds were confidently identified only to genus, they compare more favorably with black sage (*S. mellifera*) than with chia (*S. columbariae*) seeds, even though there is no clear ethnohistoric indication that the Chumash ate black sage (Timbrook 2007:184). The "other" category at Sunburst includes relatively equal amounts of clover (14%), and ~9% each of sunflower family, grasses, tarweed, miner's lettuce, and phacelia, indicating that the remaining seed assemblage is relatively diverse.

*Plant Communities*

A comparison of the relative proportions of the terrestrial plant communities represented by the archaeobotanical remains provides information about ancient plant community structure and abundance in the vicinity of each site. Any change in the use of various plant communities through time at the same site may reflect actual changes in the ancient plant communities through time, a change in foraging patterns, or both. Variation in plant communities represented at different sites may be largely due to differences in plant community structure near each site and/or differences in the seasonal occupation. Regardless of these factors in interpreting ancient plant communities near each site, it is useful to attempt reconstructions of the terrestrial environment encountered by island peoples in the past.

Table 7.4 presents the relative proportions of the plant communities represented by the archaeobotanical data from each site. Except for the Sunburst site, plants from grassland communities dominate the archaeobotanical assemblages at Brodiaea Ridge and Diablo Valdez through time. An emphasis on taxa from grasslands in the Early and Late Early Periods at Diablo Valdez is clear, with >92% of the food plants coming from this community type. Grassland taxa continue to dominate the Diablo Valdez assemblage later in time, although an increase in the relative proportion of oak woodland taxa (i.e., acorns) is seen in the Middle and Late Periods, consistent with the proportionate increase in acorn nutshell. Plant foods from chaparral communities remain relatively consistent through time at Diablo Valdez, albeit in relatively low proportions overall. Low proportions of plant foods from riparian/wetland communities are consistent through time beginning during the Late Early Period. These plant foods may have come from the spring just east of the site. Even though the Diablo Valdez site is located within some of the most productive oak woodland habitat

Table 7.4. Relative Proportion (%) of Plant Communities Represented at Each Site

| | **Diablo Valdez** | | | | **Sunburst** | **Brodiaea Ridge** |
|---|---|---|---|---|---|---|
| | *Early* | *Late Early* | *Middle* | *Late* | *Late* | *Early-Late* |
| *Grassland* | 92.4 | 93.3 | 64.1 | 75.4 | 37.5 | 76.4 |
| *Oak Woodland* | 2.3 | 3.4 | 30.8 | 17.5 | 7.4 | 5.7 |
| *Chaparral* | 5.3 | 2.6 | 2.6 | 2.7 | 52.7 | 14.0 |
| *Riparian/Wetland* | -- | 0.7 | 2.6 | 1.1 | -- | 3.8 |
| *Multiple* | -- | -- | -- | 3.3 | 2.5 | -- |

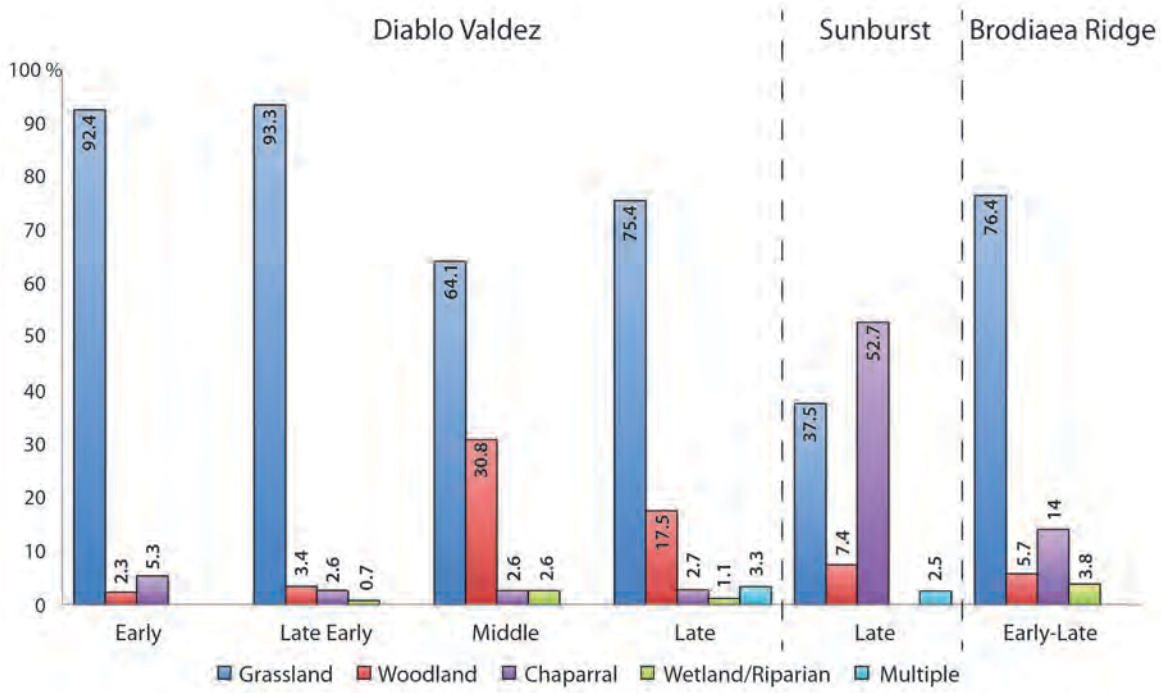


Figure 7.3. Relative Proportions of Plant Communities Represented at All Sites

on the island today, the dominance of taxa from grassland communities through time points towards the importance of grasslands on the islands.

While plant foods from grassland communities dominate the assemblages at Diablo Valdez and Brodiaea Ridge, the archaeobotanical data from Sunburst indicate an emphasis

on plant foods from chaparral communities, which is not necessarily surprising given the relative abundance of manzanita berry pits and seeds of black sage recovered at this site. Nevertheless, the food plants at Sunburst were procured primarily from chaparral (~53%) and grassland (~38%) communities, while plants from oak woodland communities were only minimally exploited.

**Determining Season of Occupation Through Time**

The discussion of seasonality focuses on the plant remains alone and does not include evidence from faunal remains, as bone was sorted only to class and no isotope studies were conducted on shellfish. Determining the season of occupation for archaeological sites based on botanical data alone can be difficult, as plant resources (particularly small seeds, pits, and nuts) are often stored for use throughout the winter, and very few taxa are indicative of collection during the winter. The season of availability for most flowering plants is derived from the blooming period, offset by approximately one month to account for the maturation of the seeds. Exceptions to this include pine seeds, acorns, and manzanita berries, which take longer to develop after flowering, yet have well documented maturation and collection times, indicated below. Brodiaea is another exception, available for harvest nearly year-round, as described in more detail below.

*Evidence from Brodiaea Corm Remains*

Brodiaea corms undergo seasonal morphological changes annually that can be identified on well-preserved archaeobotanical corms (Gill 2014). The seasonal morphological characteristics described below are all based on field observations and growth experiments

with blue dicks collected on Santa Cruz Island between 2009 and 2013 and should be broadly applicable to all species within the brodiaea complex. The dates assigned to seasonal boundaries were determined based on modern equinox and solstice dates, which fluctuated only slightly through time.

Winter: December 21-March 20. Beginning in the early winter months and into early spring around March, blue dicks corms undergo significant change. The parent corm begins to wither from its base, using its reserved starches to develop a new corm on top, giving the appearance that the corm is dividing in two (Figure 7.4) (Keator 1968; Rimbach 1902; Smith 1930). As the growth of the new corm on top progresses, the old corm beneath becomes progressively more withered as it transfers its energy to the new developing corm (Figure 7.8b). Eventually the old corm withers entirely, including the remnant withered adventitious roots, yet it remains attached to the new corm at its base (Figure 7.4a and 7.5b) (Schlising and Chamberlain 2006; Smith 1930). As the "dividing" corm nears its final stages, cormlets (also known as cormels or offsets) are formed from axillary buds around the base of the new corm (Figure 7.4c) (Hoover 1940; Schlising and Chamberlain 2006:322; Smith 1930). The number of cormlets produced generally depends on the size of the mother corm (which increases with age), sometimes numbering over 15 per plant (Han et al. 1991; Keator 1968), and is genus dependent, with *Dichelostemma* consistently producing more than *Triteleia*, which usually produce only 1 or 2 cormlets each year (Han 2001; Schlising and Chamberlain 2006). Unless detached via mechanical means such as digging, the cormlets remain attached to the parent corm and are protected by the fibrous outer coating (Figure 7.5) until the following winter when the parent corm divides again.

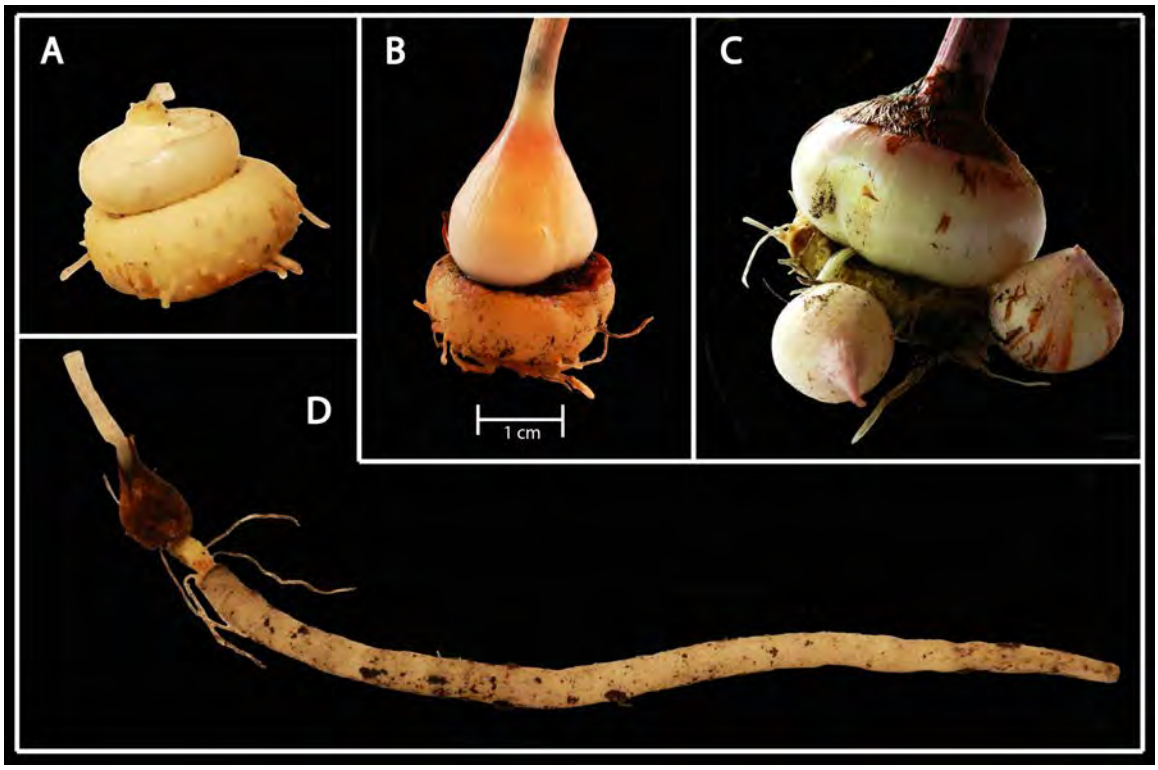


Figure 7.4. Winter Brodiaea Corm Development: a) Beginning stage of new corm development. Note the adventitious root scars around the base of the old corm (21 Jan 2013); b) Intermediate stage of new corm development and withering old corm (31 Jan 2014); c) Final stages of new corm development with the old corm nearly entirely withered below. Two cormles grow from axillary buds at the base of the new corms (31 Jan 2014); d) Cormlet producing a single contractile root (21 Jan 2013). Santa Cruz Island, CA.

Cormlets formed during the previous year also undergo significant change during the winter after they were first produced. Each cormlet develops a contractile root (Figure 7.4d), the primary function of which is to pull the cormlet deeper into the ground and away from the parent corm (Schlising and Chamberlain 2006). Each small cormlet shrinks in size, using the majority of its energy to produce the proportionately large contractile root, measuring upwards of 20 cm long and 3 to 4 mm wide (Keator 1968; Rimbach 1902; Smith 1930:921). Rather than tasting starchy like the corm itself, the raw contractile root is high in water content, slightly sweet, and crunchy in texture (author's personal observation). Once the

cormlets have moved lower into the soil, the contractile root is resorbed, and the cormlet grows until it is large enough to flower, usually in the second year, dependent on favorable environmental conditions (Dafni et al. 1981). Contractile roots are produced by cormlets only in their first year and never by a parent corm.

Spring: March 20-June 21. As the dividing corms reach their final stages, the plants begin to produce flower stalks. Brodiaea typically flowers in spring, usually between late March and late May or early June in the Santa Barbara Channel region (Junak et al. 1995). Each plant produces between 1 and 5 flower stalks, each around 50 cm tall and with a cluster of flowers at the end, usually ranging from blue to purple in color, although some species produce white (*Triteleia hyacinthina*), or even red (*D. ida-maia*) flowers. After flowering, the dried flower stalks can remain upright in areas not subject to high winds or mechanical breakage, a reminder of their presence throughout the dry summer months.

During flowering and after going to seed, the surfaces of the parent corms are smooth when the outer fibrous coating is removed (Figure 7.5b, c). The previous year's withered corm remains attached to the base of the parent corm (Figure 7.5b) and is removed prior to consumption (Figure 7.5c). The corms eaten during this time of year tend to be very starchy and sticky on the teeth, even after roasting (author's personal observation), and are a likely culprit behind high rates of dental caries seen in island populations (Walker and Erlandson 1986). The apparent higher levels of carbohydrates in corms during this time of year may have been important for island populations with access to abundant protein (i.e., shellfish, sea mammals, birds, fish), and future research into the seasonal changes of corm nutritional properties is warranted.

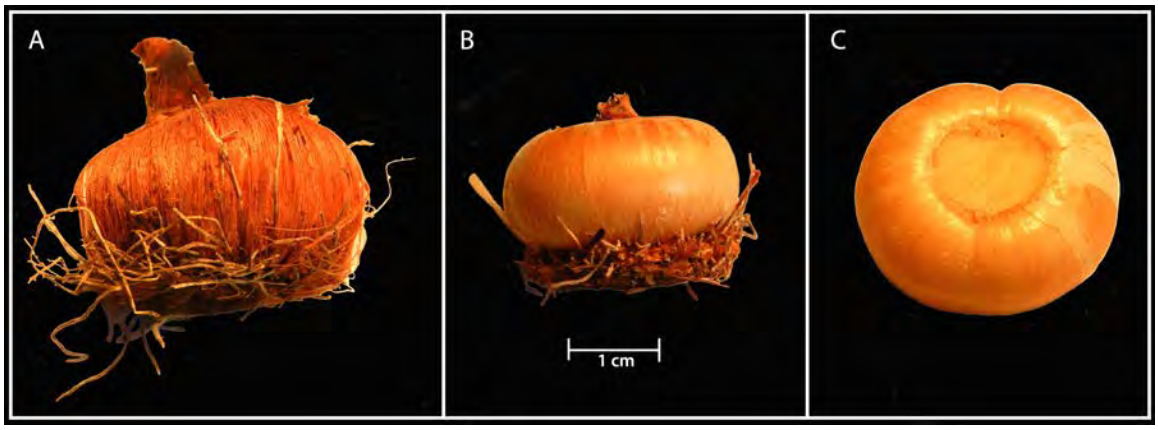


Figure 7.5. Spring/Summer Brodiaea Corm Development: a) corm with fibrous outer coating; b) corm with fibrous outer coating removed. Note the remnant withered corm and adventitious roots from the previous year attached at the base; c) base of corm with remnant old corm removed. Note the smooth sides around the base of the corm (6 Jun 2013). Santa Cruz Island, CA.

Summer: June 21-September 22. During the summer months, the corms of brodiaea enter a dormant period, an apparent adaptation to the seasonal drought conditions experienced in Mediterranean climates (Dafni et al. 1981; Schlising and Chamberlain 2006; Smith 1930). The flower stalks and leaves die back once the flowers have gone to seed, concentrating the plant's energy into the underground corm. The predictable dry summers of the Santa Barbara Channel region typically last from late June through late September, during which time there are no significant changes in corm morphology—they have smooth sides (Figure 7.5b, c). While the cumulative effects of fog drip, which is highest during the summer (see Chapter 2), on blue dicks corms during the summer is not fully understood, it does not appear to affect corm morphology. However, Smith (1930:926) noted that "corms growing near water as a rule produce more offsets than those in drier habitats," suggesting that areas that receive substantial amounts of water from fog drip may be more productive for brodiaea corms.

Fall: September 22-December 21. The emergence from dormancy usually occurs during fall, when the corms begin to produce new leaf shoots and adventitious roots in anticipation of fall and winter rains (Schlising and Chamberlain 2006). The leaf shoots themselves are edible (personal observation), and may provide a good source of vitamins. Furthermore, the leaf shoots provide a clear indication where the most abundant underground corms occur. The adventitious roots anchor the corm more securely in the ground and provide nutrients to the corm from the surrounding soil, allowing cormlets to grow larger as well. The timing of the emergence from dormancy in any given year may vary slightly between plant populations located in highland versus lowland settings on the Channel Islands, and possibly elsewhere in California as well. Highland locations on the islands are consistently subjected to greater amounts of summertime coastal fog and rainfall precipitation than lower elevations (Fischer and Still 2007:7; Glassow et al. 2008), which may allow for higher overall corm productivity as well as emergence from dormancy slightly earlier in highland settings on the islands. The newly emerging adventitious roots, which occur only around the basal margin of the corm, appear first as peak-like features (Figure 7.6a, b) and continue to grow outward (Figure 7.6c). Given the range in climatic fluctuations throughout the Holocene, the time frame for adventitious root growth likely fluctuated through time as well, possibly ranging from late August through November. Nevertheless, adventitious roots are formed after summer dormancy, and before division occurring in winter. Based on my field observations, corms eaten during this period are noticeably less starchy and slightly sweeter than those eaten in spring or summer, as the stored starches in the corm are used for adventitious root growth.

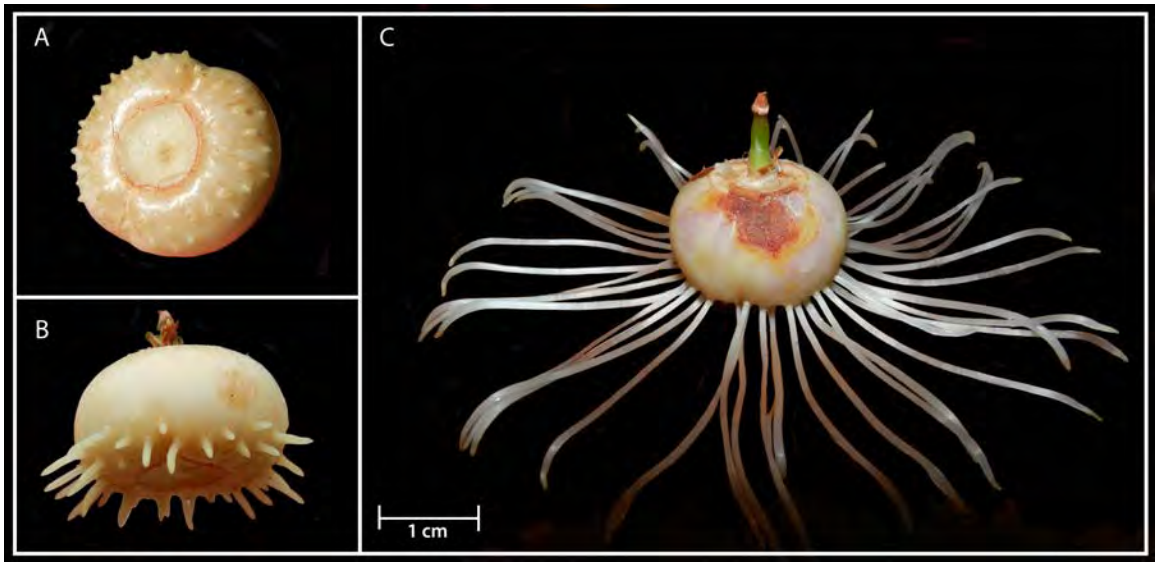


Figure 7.6. Fall Brodiaea Corm Development: a) Adventitious roots just beginning to emerge, exhibiting peak-like features around the basal margins; b) Emergence of adventitious roots at base and leaf shoot on top; c) Adventitious roots continue to grow once fully emerged. Note that adventitious roots form around the basal margins of the corm only (26-30 Sept 2013). Santa Cruz Island, CA.

Some botanical literature suggests a second dormancy period in brodiaea during the winter months (Smith 1930:920). As with summer dormancy patterns, variation in timing and duration of winter dormancy may be dependent on regional environmental conditions. Santa Cruz Island rarely experiences freezing temperatures, which may reduce the advantage of a long winter dormancy not only on the island but also in southern Alta and Baja California. Nevertheless, the corms of brodiaea do not appear to experience much morphological change after the formation of adventitious roots until January, when the cycle begins again with the formation of the replacement corm and cormlets.

The annual life cycle of brodiaea corms described here is important for understanding its potential as a food source, determining season of harvest for archaeological specimens, and interpreting ethnographic descriptions of brodiaea harvest. While there are undoubtedly changes in nutritional properties of corms throughout the various stages of its annual life

cycle (e.g., variation in starches) the underground parts, including the corm, cormlets, and contractile roots, are potentially edible *year round*. The corm is technically edible at any stage of development, although the withering old corm is slightly tough when forming the new corm on top in the winter. The young leaf shoots are edible as well, occurring in both early spring and early fall.

Anderson and Rowney (1999) conducted experiments on blue dicks (*D. capitatum*) over a three-year period, investigating the sustainability at various harvesting regimes, ranging from 50% to 100% harvest, and replanting or not replanting cormlets. They found that blue dicks are highly resilient, with no significant difference between plots harvested at 50% versus 100% when the cormlets were replanted (Anderson and Rowney 1999:238). These harvesting experiments were conducted in the spring, after the flowering and seed stages, as has been most commonly recorded ethnographically. However, based on the life cycle of corms, harvesting in other seasons is not only feasible but would have no adverse effect on overall plant population compared with harvesting only once after seeding. A possible exception to this might be harvesting contractile roots in the winter. Over-harvesting contractile roots could easily diminish the cormlet population and therefore the overall long-term plant population.

Geophytes may be stored once harvested, but they are often baked, roasted, or dried prior to storage (Anderson 2005:295-296; Prouty 1995). Cooking the corms prior to storage effectively kills them, inhibiting further growth (i.e., adventitious root formation) after this process. While drying rather than cooking geophytes prior to storage has been documented elsewhere, the corms of brodiaea are difficult to dry completely (author's personal observation), as they are particularly well adapted to surviving dry conditions.

Carbonized archaeobotanical corms with morphological features that occur only in the fall, therefore, suggest one of two storage scenarios. First, although not consistent with the ethnographic description provided above, it is possible that brodiaea corms were harvested only in the spring and stored long term in an uncooked, un-dried state, with adventitious root formation occurring during the fall regardless of storage conditions. In this case, adventitious root growth identified on archaeobotanical corms would only indicate the *use* of stored corms during the fall, rather than the harvest itself. Alternatively, the corms of brodiaea may have been harvested, roasted, and prepared for storage as described by Librado in Chapter 3, without storing uncooked corms. In this case, adventitious root features on archaeobotanical corms would directly indicate a fall *harvest*. Archaeologically, there is no way to distinguish between adventitious roots that formed on the corms stored in a uncooked state above ground versus those that formed underground and were harvested after they formed. However, the lack of gophers or deer on the islands prehistorically would likely have precluded the necessity for storing corms, as the corms are available at any time of year and not subject to significant predation. Regardless, adventitious roots on archaeobotanical corms indicate the use of brodiaea during the fall.

*Evidence from Fruits, Berries and Non-Toxic Pits*

The majority of fruits and berries on the islands ripen during the summer, except for rose hips that ripen in the fall and toyon that ripens during the winter. Much of the Chumash ethnohistoric literature indicates that fruits and berries were eaten fresh or cooked (e.g., elderberry). However, various other groups in California commonly dried fresh fruits and berries and stored them for winter (Mead 2003; Timbrook 2007). The fruit and berries

recovered from the three sites here include those that ripen in the summer (elderberry, lemonade berry, island barberry, and manzanita) as well as the winter-ripening toyon.

*Evidence from Small Seed Remains*

Some small seeds ripen in the late spring, but the majority tend to ripen during summer. While small seeds are generally collected during the summer, they are often stored for use throughout the year. The processing costs of small seeds (e.g., winnowing, dehusking) are often cited as a primary reason for their lower rank in terms of overall return rates (Gremillion 2004; Wohlgemuth 2010). However, Gremillion (2004:228) suggested that "[i]f processing could be deferred until other tasks had been completed or curtailed, its costs would represent little to no lost opportunity." Combined with the nutritional content of various seeds (see Chapter 3), the possibility of delayed processing for small seeds may have played a role in overall foraging decisions on the islands, increasing the rank of small seeds relative to other plant foods.

*Evidence from Non-Toxic Pine Nuts*

Pine nuts were usually harvested in late summer/early fall but could be stored for long periods of time. After removing the nuts from their cones, typically using fire to burn off the pitch and open the cone, they were winnowed and toasted. The toasted pine nuts could either be cracked open and consumed right away or stored for later use. In many cases, the pine nuts would be strung together for trade and/or long-term storage. These strings of pine nuts were kept in houses to be consumed any time. In trade, "[t]hese nuts were quite valuable: one strand of [pine nuts] was worth three of shell-bead money" (Timbrook 2007:144). Only one

pine nut was recovered during this research from Late Period deposits at the Diablo Valdez site. As discussed previously, it was a large pine, most likely procured from Santa Rosa Island or the adjacent mainland through trade.

*Evidence from Toxic Nuts and Pits*

All evidence for the use of acorn at these three sites comes from the acorn nutshell or cap remains rather than acorn nutmeats. This is not surprising, but the presence of these remains does provide some clue as to the seasonal use of these sites. Although California native peoples preferred acorn of certain species such as coast live oak over others, identification of acorn nutshell to species is very difficult and was not attempted here. Regardless, acorns mature during the fall and were collected in net bags from the ground or were knocked down from a tree using a long pole. The whole acorns then were dried in the sun or in temporary outdoor granaries for fifteen to twenty days. After this time, they would be shelled, winnowed, and dried completely before being stored for longer periods. According to Timbrook (2007:156), "[a]corns do not keep well if left in the shell or outdoors for a long period of time." Therefore, the presence of acorn nutshell at these sites probably indicates that people were processing acorns during the fall, whether for immediate consumption or long-term storage.

Wild cherries ripen in the late summer, and the pits were considered an important food source in ethnohistoric accounts. Like acorns, however, they have to be processed prior to storage and then processed further prior to consumption. In order to prepare wild cherry pits for storage, they were first boiled for a short time, then dried in the sun for several days prior to cracking them open. The kernels inside were then removed, and these could be stored

for a long period of time or leached and prepared for immediate consumption (Timbrook 2007:152). The wild cherry remains identified at the Diablo Valdez site contain both the kernel and the exterior portion of the pit, suggesting the remains were probably freshly collected rather than stored in a cache.

*Seasonal Indicators from the Sunburst Site*

Table 7.5 presents a summary of the seasonal availability of the various plant resources identified at the Sunburst site. This seasonal availability chart includes all possible seasons in which a particular resource could have been collected. Overall, the majority of plant taxa represented in the archaeobotanical assemblage were available from mid-spring, through the summer and into the fall. No adventitious roots (indicative of a fall harvest) were identified on any corms or corm fragments at the Sunburst site. The presence of acorn nutshell, however, points to a possible fall occupation.

Table 7.5. Seasonal Availability of Plant Taxa Identified at Sunburst

| Genus | Common Name | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Brodiaea* | Brodiaea | | X | X | X | X | X | X | X | X | X | X | |
| *Claytonia* | Miner's Lettuce | | | X | X | X | X | | | | | | |
| *Atriplex* | Saltbush | | | | X | X | X | | | | | | |
| *Marah* | Wild Cucumber | | | | X | X | X | X | | | | | |
| *Phacelia* | Phacelia | | | | X | X | X | | | | | | |
| *Salvia* | Chia, Sage | | | | X | X | X | X | | | | | |
| *Rhus* | Lemonade Berry | | | | | X | X | X | X | | | | |
| *Trifolium* | Clover | | | | | X | X | X | | | | | |
| *Arctostaphylos* | Manzanita | | | | | | X | X | X | X | | | |
| *Hypericum* | Tinker's Penny | | | | | | | X | X | | | | |
| *Madia* | Tarweed | | | | | | | X | X | X | X | | |
| *Quercus* | Acorn | | | | | | | | | X | X | X | |

*Seasonal Indicators from the Diablo Valdez Site*

Tables 7.6 – 7.9 present a summary of the seasonal availability of each plant resource identified at Diablo Valdez per time period. Overall, the plant taxa represented in these samples were available from early to mid spring through the summer and into the fall for all time periods. The presence of toyon in the Late Period deposits is the best direct evidence for occupation of the site during winter, although it occurs in very low density and abundance. As no acorn nutshell was recovered from Middle Period deposits, evidence for use of the site during the fall appears lower compared with other time periods.

Table 7.6. Seasonal Availability of Plant Taxa at Diablo Valdez during the Early Period.

| Genua | Common Name | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Early** | | | | | | | | | | | | | |
| *Euphorbia* | Spurge | X | X | X | X | X | X | X | X | X | | | |
| *Brodiaea* | Brodiaea | | X | X | X | X | X | X | X | X | X | X | |
| *Atriplex* | Saltbush | | | | X | X | X | | | | | | |
| *Calandrinia* | Red Maids | | | | X | X | X | X | | | | | |
| *Marah* | Wild Cucumber | | | | X | X | X | X | | | | | |
| *Phacelia* | Phacelia | | | | X | X | X | | | | | | |
| *Poa* | Blue Grass | | | | X | X | X | X | X | | | | |
| *Salvia* | Chia, Sage | | | | X | X | X | X | | | | | |
| *Sisyrinchium* | Blue-Eyed Grass | | | | X | X | X | | | | | | |
| *Eriogonum* | Buckwheat | | | | | X | X | X | X | X | X | X | |
| *Rhus* | Lemonade Berry | | | | | X | X | X | X | | | | |
| *Ruppia* | Ditchgrass | | | | | X | X | | | | | | |
| *Trifolium* | Clover | | | | | X | X | X | | | | | |
| *Arctostaphylos* | Manzanita | | | | | | X | X | X | X | | | |
| *Heliotropium* | Seaside Heliotrope | | | | | | X | X | | | | | |
| *Adenostoma* | Chamise | | | | | | | X | X | X | | | |
| *Chenopodium* | Goosefoot | | | | | | | X | X | X | | | |
| *Hypericum* | Tinker's Penny | | | | | | | X | X | | | | |
| *Quercus* | Acorn | | | | | | | | | X | X | X | |

Table 7.7. Seasonal Availability of Plant Taxa at Diablo Valdez during the Late Early Period.

| Genua | Common Name | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Late Early** | | | | | | | | | | | | | |
| *Euphorbia* | Spurge | X | X | X | X | X | X | X | X | X | | | |
| *Brodiaea* | Brodiaea | | X | X | X | X | X | X | X | X | X | X | |
| *Aphanes* | Lady's Mantle | | | X | X | X | | | | | | | |
| *Atriplex* | Saltbush | | | | X | X | X | | | | | | |
| *Calandrinia* | Red Maids | | | | X | X | X | X | | | | | |
| *Galium* | Bedstraw | | | | X | X | X | X | X | | | | |
| *Marah* | Wild Cucumber | | | | X | X | X | X | | | | | |
| *Phacelia* | Phacelia | | | | X | X | X | | | | | | |
| *Poa* | Blue Grass | | | | X | X | X | X | X | | | | |
| *Salvia* | Chia, Sage | | | | X | X | X | X | | | | | |
| *Phalaris* | Canary Grass | | | | | X | X | X | | | | | |
| *Arctostaphylos* | Manzanita | | | | | | X | X | X | X | | | |
| *Potamogeton* | Pondweed | | | | | | X | X | X | | | | |
| *Adenostoma* | Chamise | | | | | | | X | X | X | | | |
| *Chenopodium* | Goosefoot | | | | | | | X | X | X | | | |
| *Quercus* | Acorn | | | | | | | | | X | X | X | |
| *Pinus* | Pine | | | | | | | | X | X | X | | |

Table 7.8. Seasonal Availability of Plant Taxa at Diablo Valdez during the Middle Period

| Genua | Common Name | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Middle** | | | | | | | | | | | | | |
| *Brodiaea* | Brodiaea | | X | X | X | X | X | X | X | X | X | X | |
| *Claytonia* | Miner's Lettuce | | | X | X | X | X | | | | | | |
| *Calandrinia* | Red Maids | | | | X | X | X | X | | | | | |
| *Marah* | Wild Cucumber | | | | X | X | X | X | | | | | |
| *Phalaris* | Canary Grass | | | | | X | X | X | | | | | |
| *Quercus* | Acorn | | | | | | | | | X | X | X | |

Table 7.9. Seasonal Availability of Plant Taxa at Diablo Valdez during the Late/Historic Periods.

| Genua | Common Name | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Late/Historic** | | | | | | | | | | | | | |
| *Brodiaea* | Brodiaea | | X | X | X | X | X | X | X | X | X | X | |
| *Claytonia* | Miner's Lettuce | | | X | X | X | X | | | | | | |
| *Lepidium* | Peppergrass | | | X | X | X | X | | | | | | |
| *Atriplex* | Saltbush | | | | X | X | X | | | | | | |
| *Bromus* | Brome Grass | | | | X | X | X | X | X | | | | |
| *Calandrinia* | Red Maids | | | | X | X | X | X | | | | | |
| *Dendromecon* | Bush Poppy | | | | X | X | X | X | X | X | X | X | |
| *Lotus* | Deerweed | | | | X | X | X | X | | | | | |
| *Marah* | Wild Cucumber | | | | X | X | X | X | | | | | |
| *Phacelia* | Phacelia | | | | X | X | X | | | | | | |
| *Achillea* | Yarrow | | | | | X | X | X | X | X | | | |
| *Eriogonum* | Buckwheat | | | | | X | X | X | X | X | X | X | |
| *Phalaris* | Canary Grass | | | | | X | X | X | | | | | |
| *Silene* | Catchfly | | | | | X | X | X | X | | | | |
| *Trifolium* | Clover | | | | | X | X | X | | | | | |
| *Arctostaphylos* | Manzanita | | | | | | X | X | X | X | | | |
| *Potamogeton* | Pondweed | | | | | | X | X | X | | | | |
| *Chenopodium* | Goosefoot | | | | | | | X | X | X | | | |
| *Morella* | Wax Myrtle | | | | | | | X | X | X | | | |
| *Sambucus* | Elderberry | | | | | | | X | X | X | | | |
| *Hemizonia* | Tarweed | | | | | | | | X | X | X | X | |
| *Quercus* | Acorn | | | | | | | | | X | X | X | |
| *Heteromeles* | Toyon | X | X | | | | | | | | | | X |

*Determining Season of Harvest from Archaeobotanical Brodiaea Corms*

Because the old corm is replaced every winter as described above, the morphological characteristics described for each season are replaced annually as well. Thus, identifying adventitious roots or root scars on carbonized corms indicate a fall harvest, whereas smooth corms with no signs of such features must have been harvested after flowering in the late spring/early summer, but prior to adventitious root formation.

The excellent preservation of a large quantity of whole, carbonized brodiaea corms at Diablo Valdez provides an opportunity to investigate the season of harvest based on corm

morphology. The identification of the presence or absence of adventitious root growth was conducted conservatively. As a result, most carbonized corms were not conclusively assigned to one category or another. The positive identification of adventitious root scars and emerging roots is considerably easier than identifying their absence, particularly on small fragments. In addition, most of the deposits at both loci pertain to the Early Period, and therefore the sample size of carbonized corms with identifiable features from this period is larger as well. Nevertheless, the archaeobotanical corms from Diablo Valdez indicate they were harvested before, during, and after the formation of adventitious roots (Table 7.10).

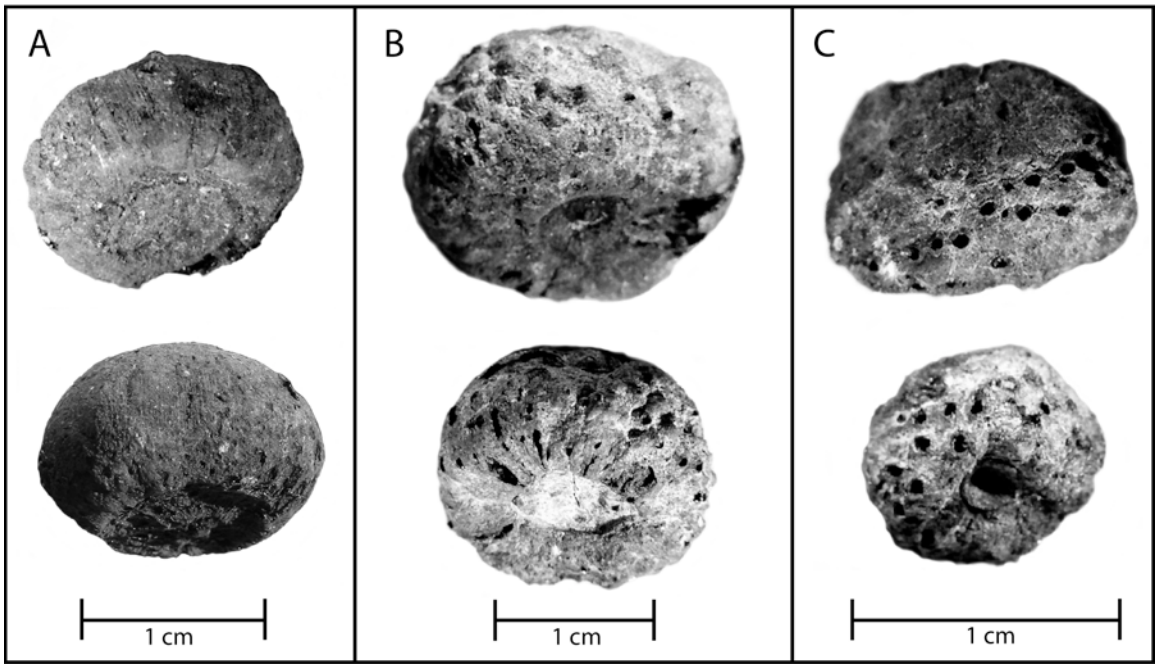


Figure. 7.7. Archaeobotanical Corms Showing Seasonal Morphology: a) carbonized corms with no adventitious root growth (locus 3, stratum 2); b) carbonized corms with emerging adventitious roots (locus 2, stratum 8, roasting pit feature; c) carbonized corms with adventitious root scars (locus 2, stratum 8, roasting pit feature.

Figure 7.7 shows archaeobotanical corms that exhibit each of the three stages of adventitious root formation, with the base of each corm shown. Smooth archaeobotanical corms indicate harvest after flowering but before adventitious root formation in fall (Figure 7.7a). This corroborates ethnographic accounts that brodiaea harvest took place in June, but it is also possible that they were harvested during the summer dormant period as well. Corms with prominent peak-like features in a regular pattern around the basal margins indicate harvest at a time just as the adventitious roots were emerging, likely between September and October (Figure 7.7b). These features must not be confused with surficial 'bubbling' that sometimes occurs during carbonization, where the entire surface of the corm may be distorted by small, irregular bubbles. Corms with adventitious root scars, characterized by nearly circular holes in a regular pattern around the basal margin, indicate harvest after the adventitious roots are fully formed in the fall but before the corm divides in the winter (Figure 7.7c).

Raw counts and weights of carbonized corms and corm fragments recovered from unit 2 excavations are presented for both loci at the Diablo Valdez site (Table 7.10). Corms and corm fragments recovered from unit 1 (excavated primarily in arbitrary levels) and column samples are not presented here, as the unit 2 data have the best stratigraphic control and abundance of whole or nearly whole corms. The proportion of corms and corm fragments assigned to one of the three stages of adventitious root formation is relatively low compared to the overall assemblage, largely due to preservation issues and the conservative approach taken in identifying these features. In many cases, however, adventitious root features were confidently identified on small fragments of carbonized corms when the basal portion of the corm is present.

Table 7.10. Corms and Corm Fragments Recovered from Diablo Valdez 1/8-inch Screened Unit Material.

| *Locus 2* Stratum | Feature | Cultural Period | Adventitious Root Stage | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Present | | Emerging | | Absent | | Not Determined | |
| | | | n | g | n | g | n | g | n | g |
| 1 | | Late | - | - | - | - | - | - | 12 | .39 |
| 2E | | Late | - | - | - | - | - | - | 7 | .36 |
| 2B-1 | Pit | Late | - | - | - | - | - | - | 32 | .89 |
| 2F | | Late | - | - | - | - | - | - | 39 | 1.20 |
| 2H | Structure/Floor | Late Early | - | - | - | - | - | - | 4 | .10 |
| 3 | | Late Early | - | - | - | - | - | - | 39 | .93 |
| 4 | | Early | 1 | .01 | - | - | - | - | 11 | .37 |
| 5 | | Early | - | - | - | - | - | - | 31 | .79 |
| 6 | | Early | - | - | - | - | - | - | 49 | 1.28 |
| 7 | Roasting Pit | Early | 20 | 5.13 | 9 | 2.89 | 2 | .72 | 313 | 11.51 |
| 8A | | Early | 1 | .01 | - | - | - | - | 48 | 1.69 |
| 8B | | Early | - | - | - | - | - | - | 39 | 1.03 |
| 9 | Roasting Pit | Early | 1 | .12 | - | - | - | - | 16 | .38 |
| 10A | | Early | - | - | - | - | - | - | 26 | 1.66 |
| *Locus 3* | | | | | | | | | | |
| 1 | | Late | - | - | - | - | - | - | 19 | .71 |
| 1A | | Late | - | - | - | - | 3 | 2.29 | 36 | 2.82 |
| 2 | | Middle | 1 | .01 | 1 | .01 | 3 | 2.54 | 44 | 5.84 |
| 2A | Hearth | Late Early | - | - | - | - | - | - | 6 | .12 |
| 3 | | Late Early | - | - | - | - | - | - | 2 | .05 |
| 4 | Hearth | Late Early | - | - | - | - | - | - | 3 | .15 |
| 5 | | Late Early | - | - | - | - | - | - | 29 | 1.06 |
| 6 | | Late Early | - | - | - | - | - | - | 6 | .10 |
| 7 | | Late Early | 1 | .01 | - | - | - | - | 31 | .52 |
| 8 | | Late Early | - | - | - | - | - | - | 19 | .36 |
| 9 | | Early | - | - | - | - | - | - | 5 | .09 |
| 10A | | Early | 1 | .01 | - | - | - | - | 19 | .60 |
| 10B | | Early | 3 | .08 | - | - | - | - | 26 | .46 |
| 11 | | Early | 2 | .03 | - | - | - | - | 27 | .54 |

Note: Adventitious roots present = late fall harvest; emerging = early fall harvest; absent = summer harvest.

Brodiaea corms appear to have been harvested and/or used during various points throughout much of the year, including fall, rather than in a single late spring/early summer harvest. The largest sample of corms with adventitious root scars present, emerging, and absent occur in the well preserved roasting pit (stratum 7), indicating apparent re-use of the same feature over multiple seasons. These data also support botanical and ecological data

that suggest blue dicks and other brodiaea corms may have been an abundant and important food resource available on California's Channel Islands during multiple seasons of the year.

**Ubiquity of Plant Food Remains Through Time**

The usefulness of ubiquity measures is that they utilize the total number of samples, with ten or more needed to make any meaningful comparisons (Popper 1988). As there were only three total samples from the Sunburst site and five from Brodiaea Ridge, the ubiquity analysis presented here focuses on Diablo Valdez. With only six samples representing the Late Period at Diablo Valdez, I chose to include those data in the ubiquity analysis only for general comparative purposes, given the limitations in making meaningful comparisons with earlier time periods. All data from features and non-food taxa were excluded in order to show the ubiquity of food plants from general midden contexts through time.

Nevertheless, the sheer volume of shellfish, fish, sea mammal and bird remains present at this upland site is testament to the importance of marine resources in the overall diet. Yet plant resources were also clearly important and were likely a significant factor in the decision to inhabit a place so far away from the coast. Table 7.11 presents ubiquity values listing the five top-ranked plant taxa at Diablo Valdez by time period except for the Middle Period. The fifth rank was removed for the Late Period, as there were only five total ubiquity rankings. The total number of samples considered within each period is: Early Period n=12; late Early Period n=11; and, Late Period n=6.

Table 7.11. Ubiquity Ranking of Plant Remains by Time Period at Diablo Valdez

| Time Period | Percent | Rank | Taxon |
|---|---|---|---|
| Late | 100 | 1 | Brodiaea, Grass Family |
| | 83.3 | 2 | Cheno-Am, Acorn |
| | 50 | 3 | Manzanita |
| | 33.3 | 4 | Miner's Lettuce |
| Late Early | 90.9 | 1 | Brodiaea |
| | 63.6 | 2 | Cheno-Am |
| | 54.5 | 3 | Grass Family |
| | 36.4 | 4 | Manzanita, Red Maids |
| | 27.3 | 5 | Phacelia |
| Early | 100 | 1 | Brodiaea |
| | 50 | 2 | Cheno-Am |
| | 41.7 | 3 | Grass Family |
| | 33.3 | 4 | Bean Family |
| | 25 | 5 | Manzanita, Acorn, Phacelia |

Brodiaea corms have the highest ubiquity value, ranked first in all time periods. Other consistently highly ranked taxa include seeds of the grass and chenopod/amaranth families, manzanita, and acorn. The high ubiquity ranking of geophytes (brodiaea), non-toxic pits (manzanita), and small seeds (cheno-ams and grasses) remains relatively consistent through time at this site. Interestingly, acorn is ranked fifth and sixth in the Early and Late Early Periods, respectively, yet appears to increase in ubiquity during the Late Period, where it is ranked second. However, as mentioned previously, the low number (<10) of total Late Period samples limits our ability to meaningfully compare ubiquity values. Regardless, geophytes are consistently the most ubiquitous plant type occurring in all but one sample, and the plant taxa with the highest ubiquity values are all available locally and within close proximity to the Diablo Valdez site.

**Diversity and Equitability**

With regard to the values presented in Table 7.12 below, the larger the number in the diversity category, the higher the diversity. The equitability index ranges from zero to one, with zero being "least equal" and one being "most equal" (Popper 1988). Diversity analysis allows for the identification of generalized (diverse) versus specialized (narrow) subsistence strategies, and by extension, site function. Like ubiquity analysis, the Shannon-Weaver index is most useful when there are high counts within each taxon. Therefore, the values for the Brodiaea Ridge and Sunburst site are interpreted with caution. Diversity and equitability values are provided by time period for the Diablo Valdez site, except for the Middle Period

Table. 7.12. Diversity and Equitability Values For Each Site

| | **Brodiaea Ridge** | **Sunburst** | **Diablo Valdez** | | |
|---|---|---|---|---|---|
| | *Early-Late* | *Late* | *Early* | *Late Early* | *Late* |
| Diversity | 2.34 | 2.17 | 2.44 | 2.17 | 1.9 |
| Equitability | 0.78 | 0.82 | 0.81 | 0.77 | 0.79 |

(n=1). It appears that the assemblage at Brodiaea Ridge and Sunburst are similarly diverse, with Sunburst being slightly more even. At Diablo Valdez, diversity and equitability are both slightly higher during the Early Period compared with later in time. The Late Period assemblage is less diverse than earlier in time and has a slightly less even distribution. However, all of these sites and time periods are similarly even, suggesting that while activities at the Diablo Valdez site may have been slightly more generalized earlier in time compared with the Late Period, the difference does not appear to be significant.

## Independent Assessments of Plant Use Through Time at Diablo Valdez

### *Density Measures*

Because relative abundance, ubiquity, and diversity/equitability values are calculated independently of density, it is also necessary to consider the degree to which densities of various taxa change through time in order to effectively evaluate change in plant use. In the figures below, the densities of each plant taxon through time at the Diablo Valdez site are summarized as notched box plots, with all feature data excluded. Using only data from general midden contexts in this analysis, the density box plots summarize the broader trends in plant processing and discard at this site through time. Only the most ubiquitous taxa are considered in these independent analyses, including brodiaea, manzanita berry, acorn, small edible seeds, wild cucumber, and wood charcoal. The Middle Period is represented by only one sample, indicated as a solid dot in the box plots below for general comparative purposes.

#### *Food Plant Remains*

The densities of plant food taxa recovered at Diablo Valdez are remarkably consistent through time, with no statistically significant differences from the Early to Late Periods.

Brodiaea Corms. A comparison of the density of brodiaea corms through time is shown in Figure 7.8. Although not necessarily surprising, given the high ubiquity value of brodiaea corms during all time periods, the densities of carbonized corms remain consistent during all time periods as well.

Manzanita Berry Pits. Densities of Manzanita berry pits are also statistically consistent through time, with slightly lower densities occurring in the late Early Period deposits compared to the earlier and later periods (Figure 7.9).

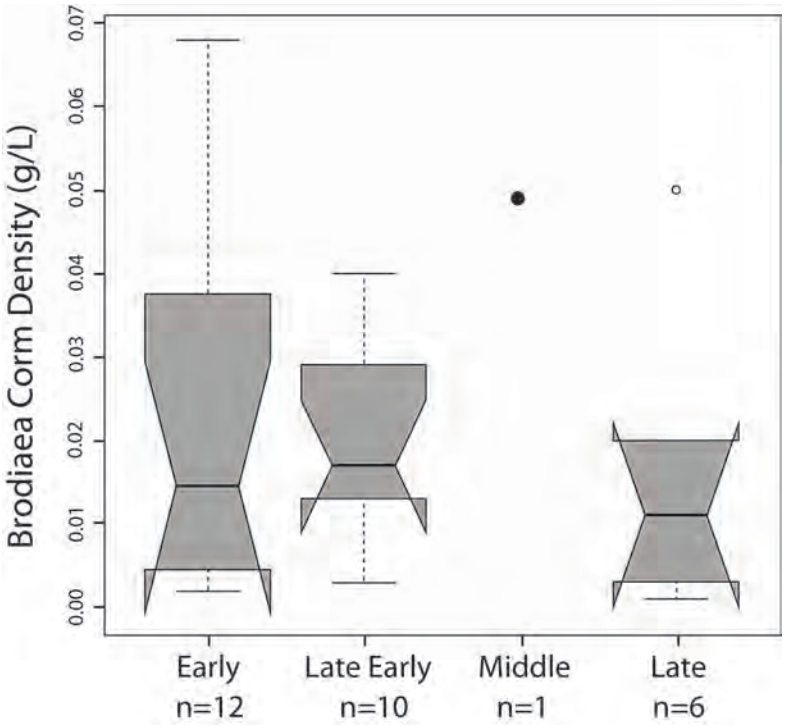


Figure 7.8. Box Plot of Brodiaea Corm Density at Diablo Valdez by Time Period

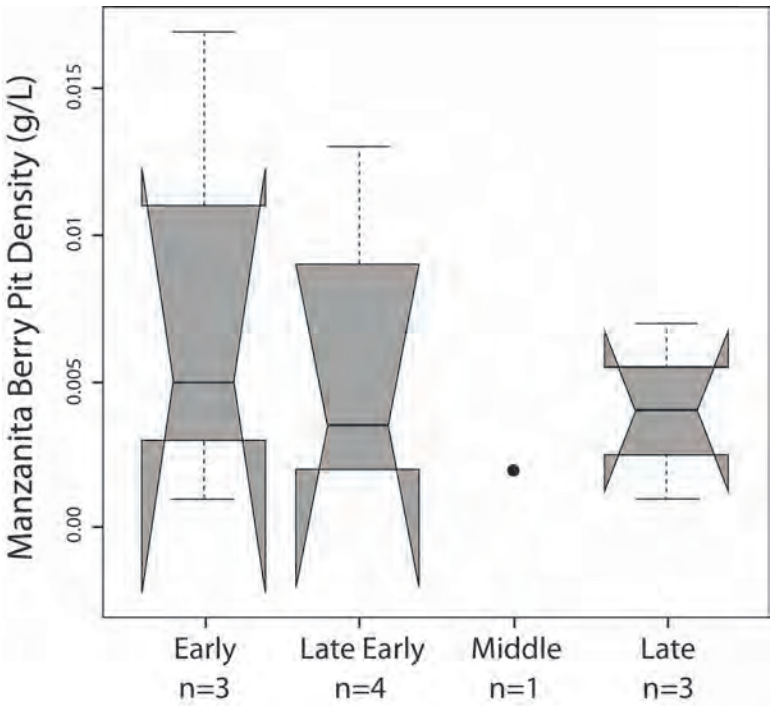


Figure 7.9. Box Plot of Manzanita Berry Pit Density at Diablo Valdez by Time Period

Acorn Nutshell. Even though acorn increases in ubiquity ranking from the Early to the Late Periods, and increases proportionately compared with other plant remains in the Middle and Late Periods, there is no statistically significant increase in acorn nutshell density through time. There does appear to be a slight increase in the range of acorn density in the Late Period deposits compared with the late Early Period deposits, yet the confidence intervals overlap (Figure 7.10).

Small Seeds. Likewise, the densities of small edible seeds also increase slightly in the Late Period, corresponding to the increase in the relative proportion of small seeds to other plant foods later in time, yet this increase is not statistically significant either (Figure 7.11). The extreme outlier seen in the Late Period represents a single sample with high seed densities, which may account for the apparent increase in relative proportion to other food plants overall.

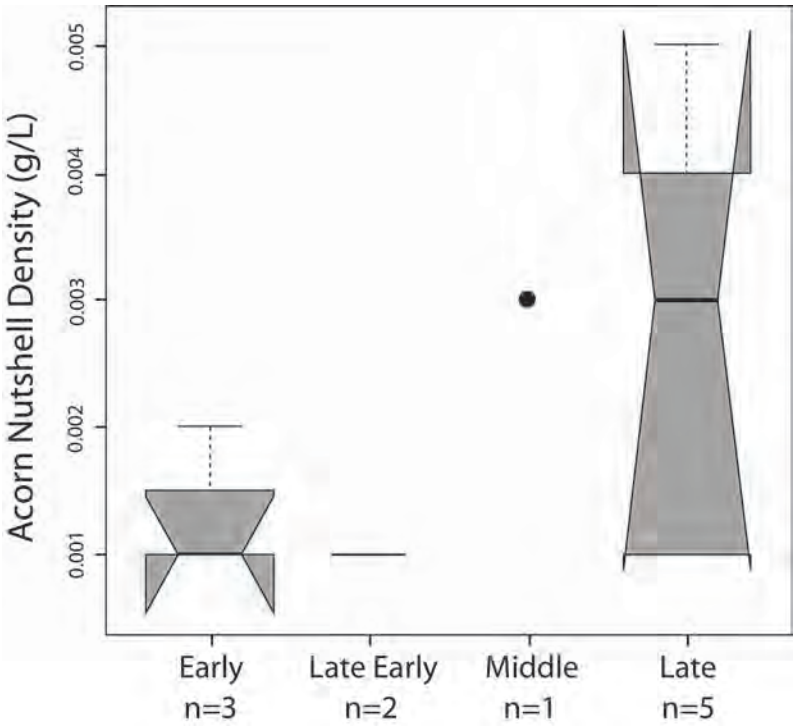


Figure 7.10. Box Plot of Acorn Nutshell Density at Diablo Valdez by Time Period

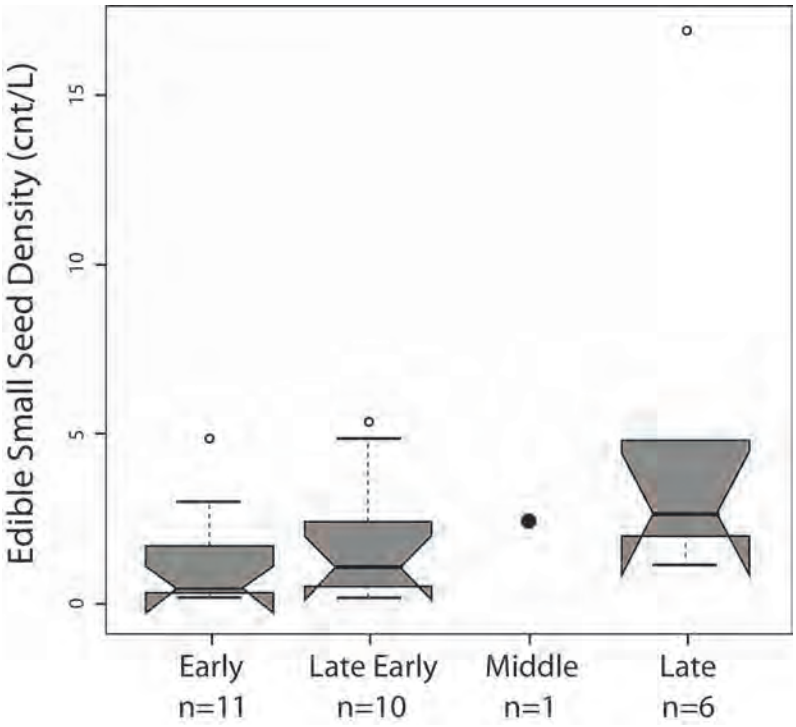


Figure 7.11. Box Plot of Small Edible Seed Density at Diablo Valdez by Time Period

*Non-Food Plant Remains*

In addition to the plant foods described above, densities of non-food plant remains are presented here to evaluate patterns of non-food related plant deposition. While other non-food plants were identified in the small seed assemblage, none was as ubiquitous as wild cucumber or wood charcoal, which were recovered from nearly every stratum at Diablo Valdez. As with the independent assessments of plant foods, wood charcoal and wild cucumber densities exclude feature data to show general trends through time.

Wood Charcoal. The wood charcoal densities through time show a statistically significant increase from the Early to the Late Early Periods (Figure 7.12). With the exception of the extreme outlier in the Late Period, densities appear to decrease slightly

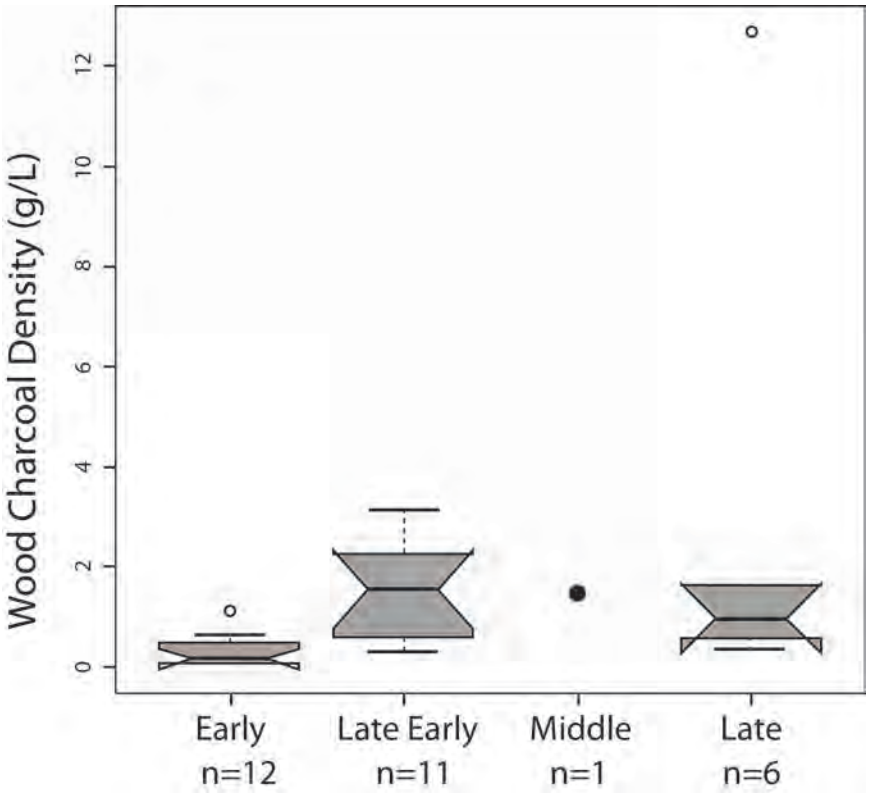


Figure 7.12. Box Plot of Wood Charcoal Density at Diablo Valdez by Time Period

compared with the Late Early Period, but not significantly so. The significant increase in charcoal density around 3000 years ago at Diablo Valdez supports other (albeit scant) paleoenvironmental data showing an increase in wood charcoal on eastern Santa Rosa Island around the same time (Anderson et al. 2010). Presumably used primarily as fuel, the increase in wood charcoal suggests an increase in fuel use, possibly due to increasing island populations, an intensification of wood fuel use, an environmental change resulting in increased availability of wood, or a combination of these factors. The extent to which the increase is wood charcoal is seen at other island sites during this time remains to be seen, however.

Wild Cucumber. Figure 7.13 presents the densities of wild cucumber seeds recovered at Diablo Valdez, presented in weight (g/L) rather than count (n/L) as the large seeds tend to

fragment easily. There is no statistically significant change through time in wild cucumber density, yet there is an increase in density from the Early to Late Early Periods, with slightly lower densities in the Late Period deposits. Wild cucumber is commonly found at archaeological sites throughout California and was identified from all time periods at Diablo Valdez, yet all parts of the plant are mildly toxic, with no known processing methods for reducing toxins. As described above, the seeds were occasionally strung as beads, used medicinally and ritually for a variety of purposes including as a salve to cure baldness and as a medium for binding pigment (S. Martin 2009; Timbrook 2007). It is possible that wild cucumber was used at Diablo Valdez as described ethnographically (primarily for medicinal/ritual purposes), although the high ubiquity and density found here and elsewhere

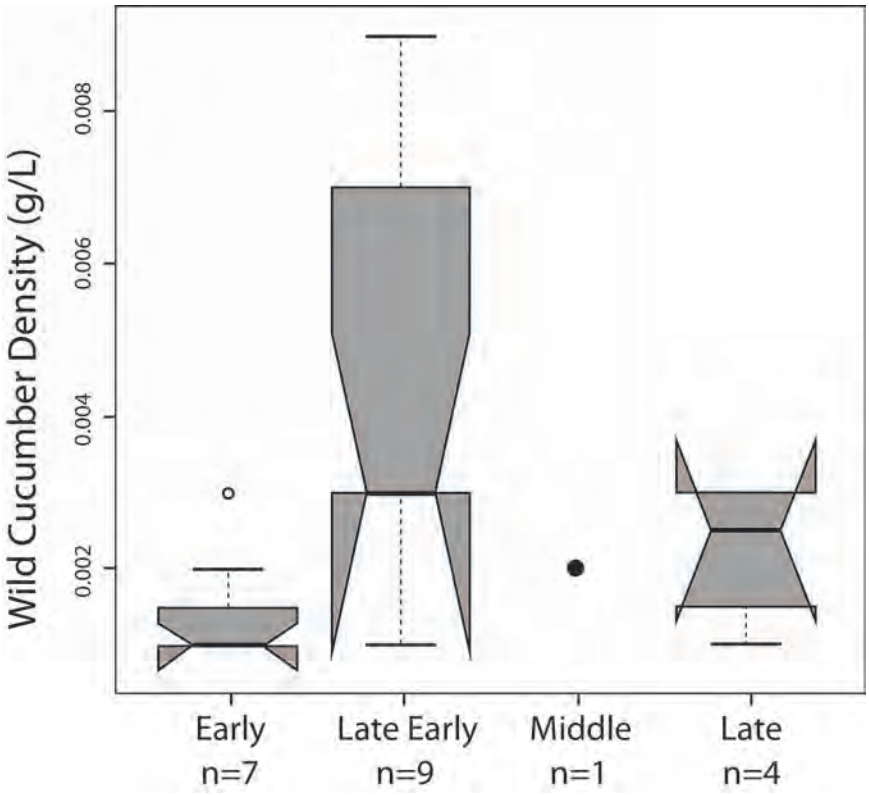


Figure 7.13. Box Plot of Wild Cucumber Density at Diablo Valdez by Time Period

throughout California is still perplexing (S. Martin 2009). It is curious that wild cucumber is found so ubiquitously in California, particularly as the seeds (identified archaeologically) were most often ground into a paste, generally resulting in a low archaeological signature. Other uses (i.e., strung as beads) may have contributed to the abundance of wild cucumber, yet the frequency with which it is identified in most California sites may suggest other uses in addition to those recorded ethnohistorically.

It is possible the fruit capsules and seeds were used for tinder/kindling. The fruit capsule of wild cucumber typically dries out by late spring, and splits open on one end to release the large seeds, with several seeds often remaining in the dried capsules throughout the summer. The many fruit capsules connected to the main vine facilitate quick collection by picking up the entire vine, which also would preclude the need to handle the spiny fruit capsules directly. Both the seeds and the fruit capsules have a high oil content, with the seeds of *M. macrocarpus* containing 54.4% oil (Earle and Jones 1962:246). Indeed, S. Martin (2009:82) reports that "Stocking (1955:120) suggested … the seeds of *Marah* may be an important source of oil as their contents readily ignite."

If wild cucumber was used as kindling in addition to its medicinal and ritual uses, we might expect a depositional pattern similar to that of wood charcoal, especially when dense, hard woods are the most locally abundant wood fuel sources at residential sites. For example, the dense wood of oak, cherry, and ironwood burn hot for a long time, with low smoke, few sparks, and produce the best coals, especially compared with other local fuel sources such as pine. These desirable fuel properties may have been especially important in constructing the roasting pits identified at Diablo Valdez, and hard woods are relatively abundant in the near vicinity. Tinder and kindling sources, on the other hand, are typically chosen for their

properties of burning hot quickly in order to catch the larger pieces on fire. Materials such as smaller twigs, leaf litter, bark, and pine needles/cones work well, but wild cucumber fruit capsules/seeds may also have been an attractive alternative. Wild cucumber is abundant on the islands, grows rapidly, encroaches swiftly on both disturbed and heavily vegetated areas alike, and may have been an abundant and reliable source of kindling/tinder in the past. If wild cucumber was used as kindling in addition to the medicinal/ritual uses described ethnographically, we might expect a depositional pattern similar to that of wood charcoal if they were used in conjunction with one another. The densities of wood charcoal and wild cucumber at Diablo Valdez do appear to show similar, albeit not identical, patterns through time, with an increase around 3000 years ago and slightly lower densities during the Late Period. Nevertheless, additional research, including identification of the wood charcoal remains, is necessary to test these ideas.

### *Standardized Measures*

In the previous section, I assessed each major taxon independently through time using density measures, which indicated that plant foods were processed and deposited uniformly through time at Diablo Valdez, while wood fuel use increased after the Early Period. Here, I present a second independent assessment of each taxon based on ratios of count (for small seeds) or weight (for large taxa) to total plant weight (excluding wood charcoal). I excluded wood charcoal from these ratios, because of the significant increase in wood charcoal densities between the Early and Late Early Periods, consistent with paleoenvironmental data from elsewhere on the northern Channel Islands.

Brodiaea Corms. The boxplots in Figure 7.14 show that the ratios of corm weight (g) to total plant weight (g) for each stratum do not change significantly through time. There is a slight decrease from the Early to the Late Early Periods, but the confidence intervals overlap, indicating the decrease is not statistically significant.

Manzanita Berry Pits. The ratios of manzanita berry pits (g) to total plant weight (g) also show no significant change through time (Figure 7.15).

Acorn Nutshell. Acorn nutshell (g) to total plant weight (g) similarly shows no significant change through time, although the confidence intervals between the Early and Late Early Periods are close to not overlapping (Figure 7.16). Regardless, the ratios of the Early and Late Periods are similar, showing there is no significant increase in acorn nutshell through time.

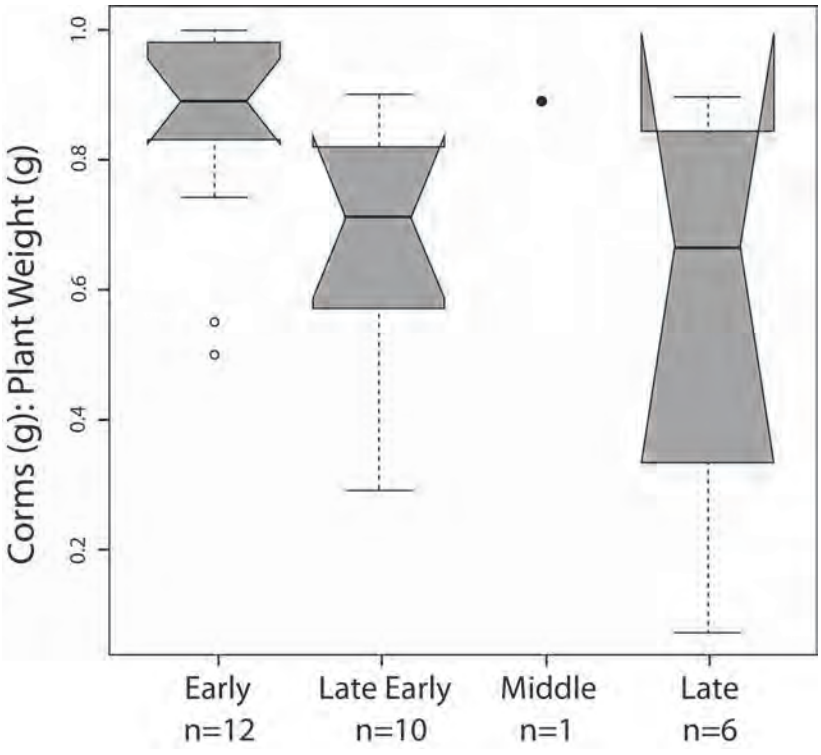


Figure 7.14. Box Plot of Brodiaea Corms to Plant Weight Ratios at Diablo Valdez

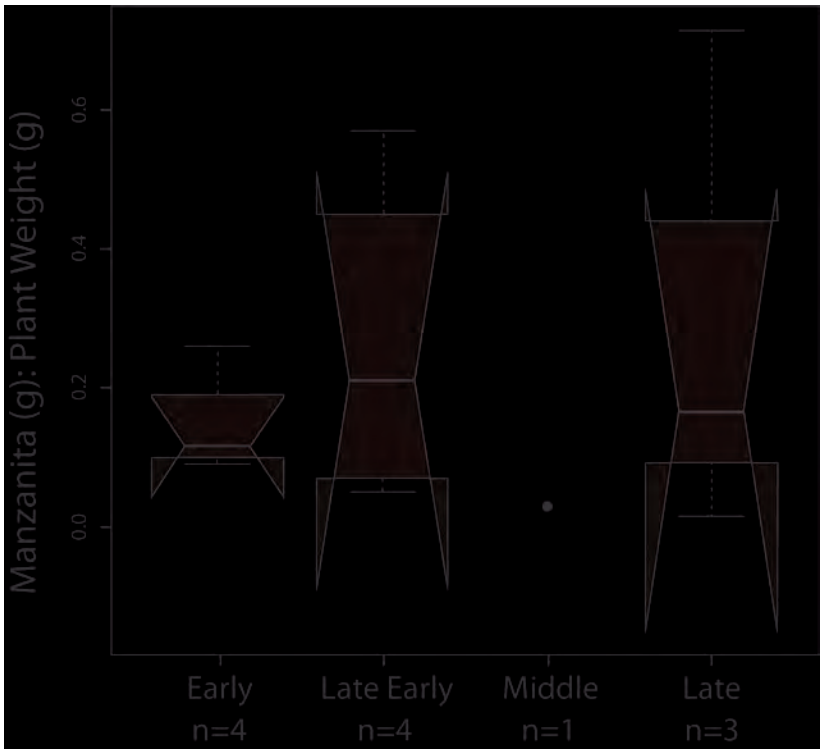


Figure 7.15. Box Plot of Manzanita Berry Pits to Plant Weight Ratios at Diablo Valdez

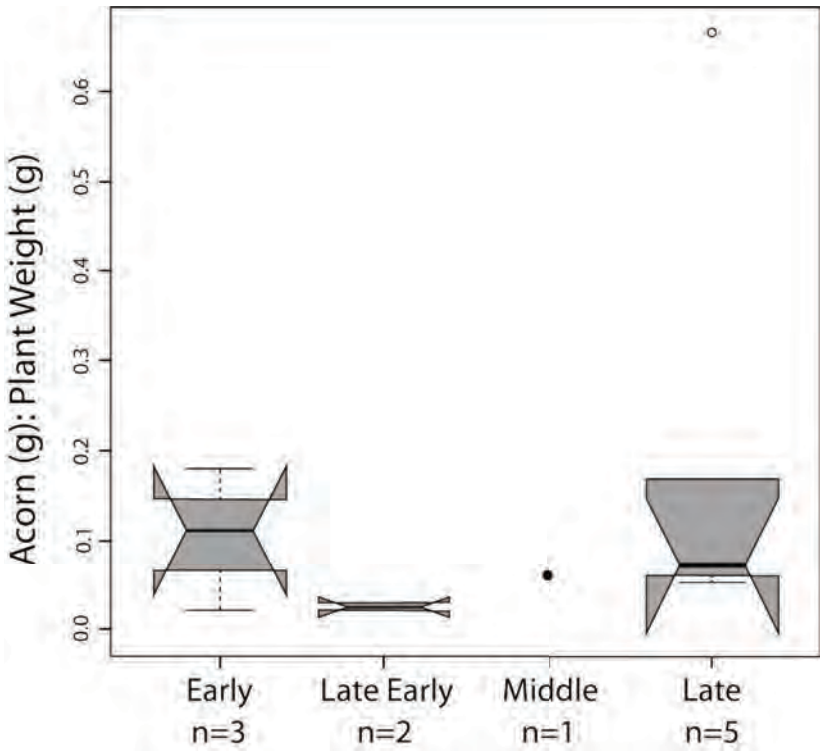


Figure 7.16. Box Plot of Acorn Nutshell to Plant Weight Ratios at Diablo Valdez

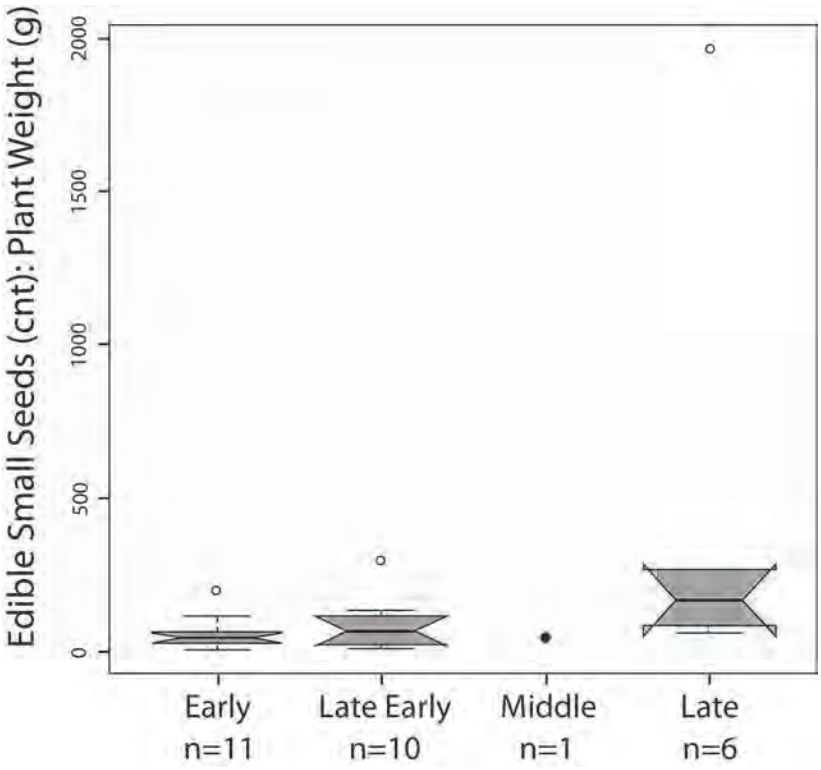


Figure 7.17. Box Plot of Edible Small Seeds to Plant Weight Ratios at Diablo Valdez

Small Edible Seeds. The ratios of small seeds (n) to plant weight (g) indicate there is a general increase in small seeds through time, but the increase is not significant (Figure 7.17). The extreme outlier in the Late Period shows that one sample contains more seeds than the others, which was also apparent in the density measures.

**Late Period Plant Use at Diablo Valdez and Sunburst**

The Diablo Valdez and Sunburst sites, located 1 km apart on either side of the northern ridge, were both occupied during the Late Period. Deposits at Diablo Valdez are more substantial, with features suggesting that a variety of domestic activities occurred here, whereas activities at Sunburst appear to have been more specialized, possibly seasonal in nature and focused on olivella bead manufacture. As described above, similar types of plant

remains were identified at both sites, although manzanita and sage seeds were more abundant relative to other plant remains (i.e., brodiaea) at Sunburst compared with Diablo Valdez. When each taxon is assessed independently using both density and standardized ratios, we are able to compare plant use at these sites.

Unfortunately, neither brodiaea corms nor acorn nutshell were identified in enough samples (>1) at Sunburst to compare these two sites using boxplots. However, food plants including manzanita and edible small seeds can be compared. Figures 7.18 and 7.19 show that there is no significant difference between the two sites in terms of density or plant weight ratios for either manzanita berry pits or edible small seeds. While the density of manzanita is lower at Sunburst than at Diablo Valdez, the ratio of manzanita to total plant weight is higher at Sunburst, possibly indicating that fewer people occupied Sunburst

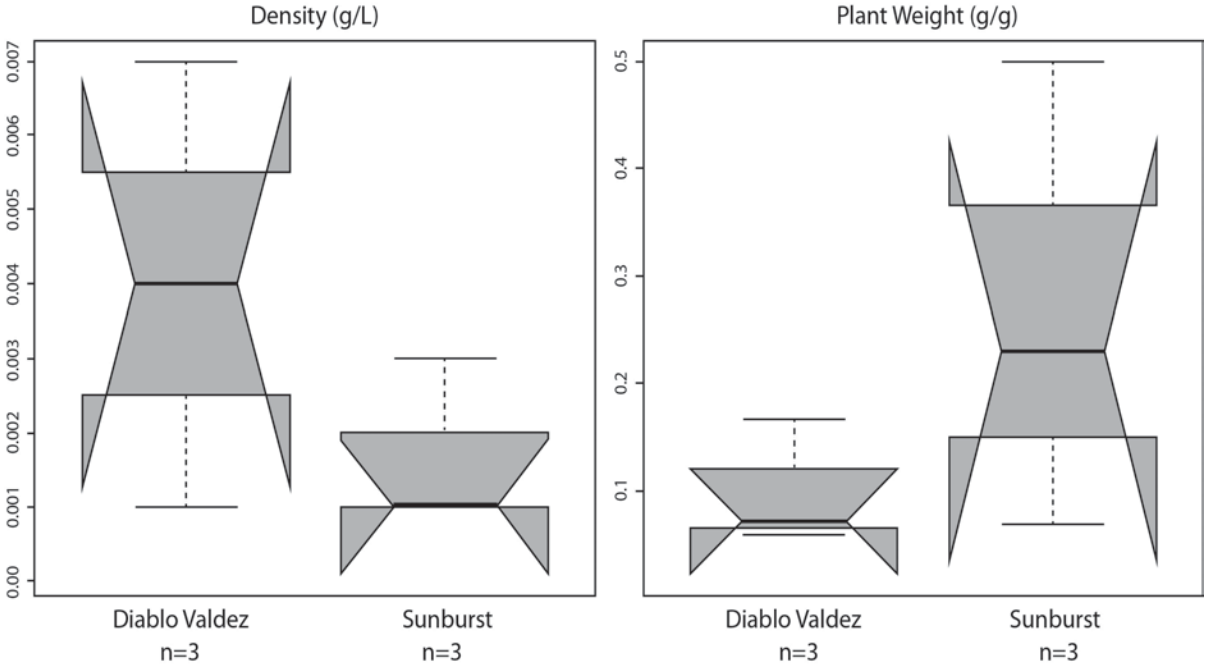


Figure 7.18. Box Plots of Late Period Manzanita Use at Diablo Valdez and Sunburst

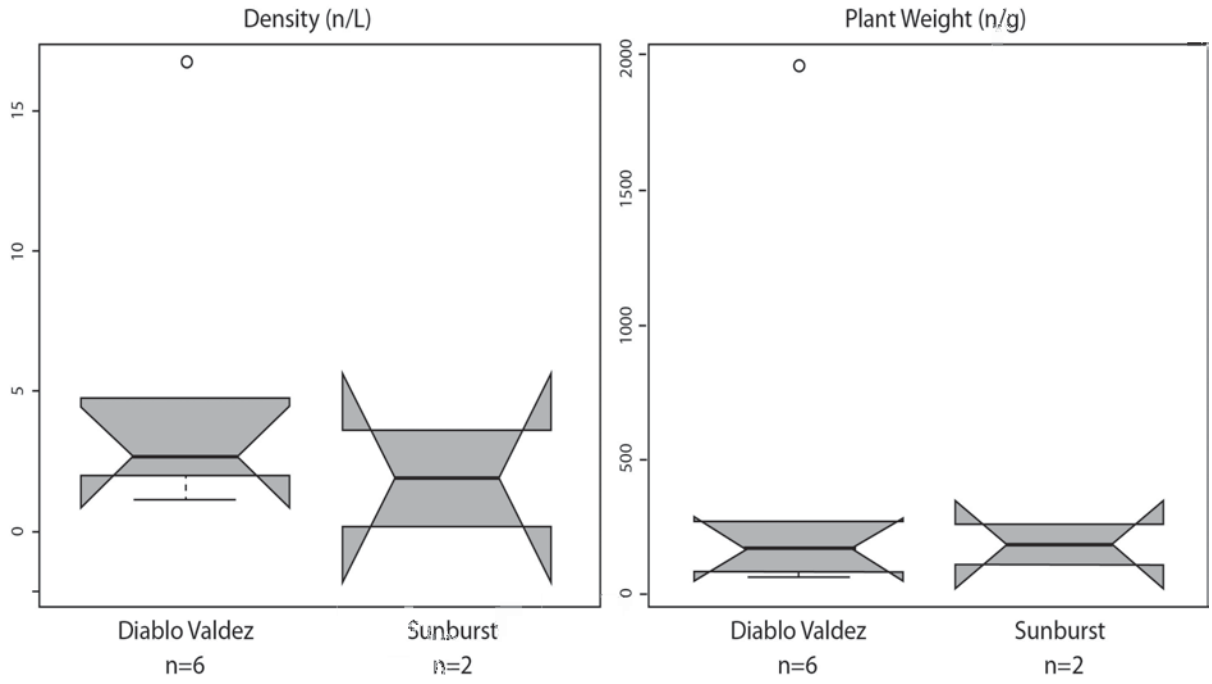


Figure 7.19. Box Plots of Late Period Edible Small Seed Use at Diablo Valdez and Sunburst

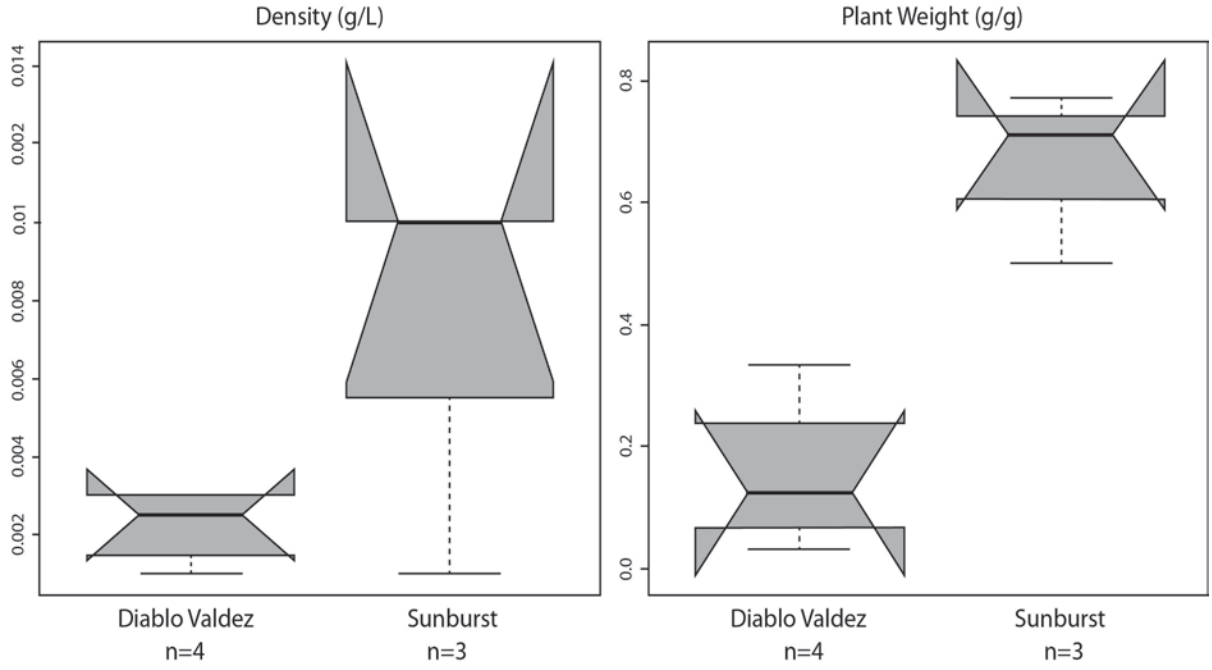


Figure 7.20. Box Plots of Late Period Wild Cucumber at Diablo Valdez and Sunburst

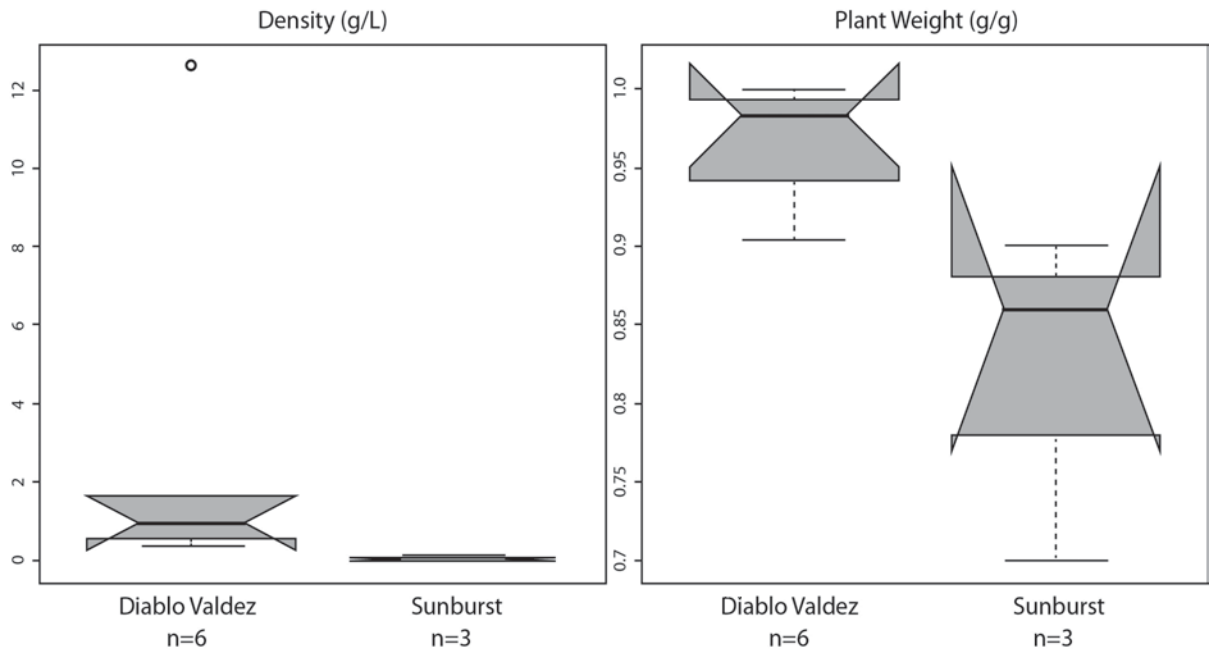


Figure 7.21. Box Plots of Late Period Wood Charcoal at Diablo Valdez and Sunburst

even though manzanita represents more of the total plant weight. The edible small seeds are comparable at the two sites using both measures, even though the relative proportions of seed types are different, with black sage seeds dominating at Sunburst and cheno-ams and grasses at Diablo Valdez. Nevertheless, the comparison of these plant foods during the Late Period indicates there is no statistically significant difference between the two sites, suggesting similar patterns of plant food exploitation at each.

In contrast, a comparison of both wild cucumber and wood charcoal at these sites does show a significant difference. Wild cucumber is significantly higher at Sunburst compared with Diablo Valdez in terms of both density and plant weight ratios (excluding charcoal) (Figure 7.20). Wood charcoal densities are significantly higher at Diablo Valdez compared to Sunburst, yet while the ratios of wood charcoal to total plant weight (including

charcoal) are also higher at Diablo Valdez compared to Sunburst, they are not significantly different (Figure 7.21).

The majority of the food plant remains recovered from Sunburst include manzanita berry pits and small seeds, predominately black sage. Neither manzanita nor small seed densities and plant weight ratios are statistically different between Diablo Valdez and Sunburst during the Late Period, but that does not necessarily mean the two sites were used in the same manner. Late Period deposits at Diablo Valdez are much more substantial, and the presence of four house depressions on the surface suggest the site was still being used as a residential base. The more ephemeral Sunburst site was likely a seasonal encampment occupied mainly during the summer (see seasonality section above), whereas plant remains from Diablo Valdez suggest a year-round occupation. The fact that there is no significant difference between manzanita and small edible seeds is interesting, and probably demonstrates that these resources were exploited similarly at both sites during the summer months when they are ripe.

Differences in the wood charcoal densities may be related to the duration of occupation in a given year, where wood was being used as fuel more intensively at Diablo Valdez than at Sunburst, resulting in significantly higher densities. Relative to total plant weight, wood charcoal (presumably used as fuel) use is lower at Sunburst than at Diablo Valdez, but not significantly so, suggesting that relative to plant foods, wood fuel was used in similar ways at both sites. Wild cucumber, however, is significantly higher at Sunburst using both independent measures, which may reflect significant differences in kindling/tinder use/availability as described above, or in other medicinal/ritual uses as described ethnographically.

## Discussion

### *The Use of Plant Foods Through Time*

The archaeobotanical data from the Brodiaea Ridge, Sunburst, and Diablo Valdez sites indicate that a variety of island plant foods were used at both large residential sites (Diablo Valdez), and smaller, more ephemeral sites where occupation likely was seasonal or short-term in nature (Sunburst). Brodiaea was recovered from all sites, as were small seeds. The Sunburst site was dominated by remains from chaparral taxa, including small seeds (55%), 41% of which were sage seeds, and manzanita berry pits (31%). The dominance of chaparral taxa at Sunburst may indicate that the chaparral habitat was more prevalent near the site than it is today, and that the occupants were targeting sage seeds and manzanita berry pits. Manzanita berry pits are high in carbohydrates (~86%), as are sage seeds (see Chapter 3). The sage seeds identified at Sunburst compare favorably with black sage (*S. mellifera*), which contain more carbohydrates (69%) per 100 g than chia (*S. columbariae*) (44.7%) (mean percent carbohydrates for each species, see Gilliland 1985). Both sage seeds and manzanita berry pits are plant foods that ripen in the summer, indicating that this site was primarily occupied during the summer, with smaller proportions of acorn nutshell (7%) suggesting it may also have been occupied during the fall. The Sunburst site provides valuable information about the use of island plant foods in the island interior during the Transitional and Late Periods, where bead manufacturing activities also took place.

While the archaeobotanical assemblage at Sunburst consisted primarily of chaparral taxa, both Brodiaea Ridge and Diablo Valdez were dominated by grassland taxa, including brodiaea, grass, and cheno-am seeds. The mixed stratigraphy at Brodiaea Ridge obscures change in plant use through time, but the stratigraphy and archaeobotanical data at Diablo

Valdez provides excellent resolution. The Middle Period was represented in only one sample, however, and must therefore be interpreted with caution.

Nevertheless, brodiaea made up ~75% of all plant types recovered at Diablo Valdez in the Early and Late Early Period deposits, with small seeds comprising between 18 and 19%. The most common taxa in the small seed assemblages are cheno-ams, between 33 and 28% in the Early and Late Early Periods (respectively), and grasses (between 25 and 24%). Other small seed taxa (38%) are relatively diverse in the Early Period, while red maids make up 31% of the small seeds in the Late Early Period. Both manzanita berry pits and acorn nutshell are proportionately low in both early periods, making up less than 4% each of the total plant assemblage. In the Middle Period, acorn nutshell increases (31%) proportionately to brodiaea (46%), while small seeds (21%) and manzanita berry pits (3%) remain similar to earlier periods. However, cheno-ams dominate (63%) the Middle Period small seed assemblage, with grasses remaining relatively similar (25%) to earlier periods. By the Late Period, small seeds proportionately dominate (57%) the total plant assemblage, comprised primarily of cheno-ams (59%) and grasses (32%), while brodiaea and acorn nutshell are 21 and 18%, respectively. Manzanita berry pits remain around 3%, and fruits occur in very low proportions (1%). Based on the relative abundances at Diablo Valdez, it appears that small seeds and acorn increase relative to brodiaea corms later in time, and that cheno-ams and grass seeds become more important as well. Plant foods from grassland habitats always dominate the assemblage, but the relative increase in acorn later in time indicates use of oak woodland habitat as well.

The large proportion of manzanita berry pits and black sage seeds recovered at the Late Period Sunburst site suggest an occupation primarily during the summer, when both of

these resources ripen. Acorn nutshell is also present, however, indicating occupation during the fall as well. The Diablo Valdez site, on the other hand, was most likely occupied year-round. Evidence for the harvest of brodiaea corms in both spring and fall is apparent in Early, Late Early, and Middle Period deposits, and the winter-ripening toyon was identified in the Late Period deposits. Seeds of spring and summer-ripening taxa were present in all strata, and acorn nutshell provides further evidence for fall occupation.

Ubiquity values of plant remains at Diablo Valdez show consistent use of brodiaea (ranked highest), grasses, and cheno-ams through time, with acorn increasing in ubiquity during the Late Period (although there are less than 10 Late Period samples). Diversity values for Diablo Valdez indicate that there is a slight decrease in plant taxa diversity during the Late Period compared with earlier in time, although it is not significant and remains relatively even through time.

Independent analyses of plant remains based on density using g/L for brodiaea corms, manzanita berry pits, and acorn nutshell, and n/L for small seeds, show no statistically significant change through time for any plant food remain. Likewise, independent assessments of each taxon using ratios to total plant weight (excluding charcoal) show no statistically significant change through time either. There are some extreme outliers for several taxa (small seeds and acorn nutshell) in the Late Period samples using these ratios, which may help explain the changes seen in relative abundance of various plant categories later in time time. Nevertheless, there appears to be no statistically significant change through time for any of the most ubiquitous plant food taxa at Diablo Valdez.

The relative proportions of plant types appear to show an increase in both acorn nutshell and small seeds in the Late/Historic Period compared with earlier in time, as do

ubiquity values for these taxa. However, when tested for significance in terms of diversity, density, and standardized by plant weight, there is no significant change in the use of plant foods for nearly 6,000 years at Diablo Valdez. This remarkably consistent plant subsistence regime is antithetical to the broader archaeological narrative for the islands, where environmental and cultural stressors supposedly necessitated an increasing reliance on the mainland for plant foods later in time. Only two obvious mainland taxa (large-seeded pine and wax myrtle) were identified, both of which occurred in very low densities. The large pine seed was present in Late Early Period deposits at Diablo Valdez, while wax myrtle was present only in Late Period deposits. The minimal presence of obvious mainland plant remains through time suggests that although the Island Chumash did engage in cross-channel trade to acquire mainland plants, it does not appear to have been nearly as extensive or intensive later in time as previously thought.

*Re-Evaluating Island Plant Food Rankings*

In Chapter 3, I suggested a revised ranking of island plant foods based primarily on carbohydrate content, seasonal availability, and processing costs. In this scheme, I suggested the following rank for island plant food categories: 1) geophytes, 2) kelps and seaweeds, 3) fruits, berries, and pits, 4) small seeds, 5) leaves, stems, stalks and flowers, 6) non-toxic nuts, 7) toxic nuts, and 8) aquatic roots/rhizomes. Obviously, not all categories of these potential food plants are equally preserved in archaeological site deposits, and some like kelps/seaweeds and leaves/stems may be absent from the macrobotanical record entirely. Nevertheless, they are important to consider, however difficult they may be to compare with plants that are readily preserved in the macrobotanical assemblage.

By combining the plant food remains identified at the sites analyzed here with those analyzed by previous researchers (see Chapter 3, Table 3.1), we see that some taxa are consistently present in various sites through time and space, while others are not. Table 7.13 presents the food plants that generally occur in at least 50% of the 12 domestic sites that have been analyzed for archaeobotanical remains on Santa Cruz Island, showing the number of sites where each taxon occurs. I have also included pine, because the small-seeded Bishop pine occurs on Santa Cruz, and it was presumed highly ranked. Essentially, Table 7.13 presents ubiquity values for various plant foods at various domestic island sites across space and time, showing broad-scale trends on Santa Cruz Island. A variety of factors may account for the presence/absence of particular plant foods at various sites (site location, duration of occupation, preservation), but the broader trends are nevertheless informative for ranking island plant foods on a broader scale.

Table. 7.13. Ubiquity of Food Plants From 12 Domestic Sites on Santa Cruz Island

| Food Plant | Type | # Sites | Ubiquity Value |
|---|---|---|---|
| Brodiaea | Geophyte | 12 | 100% |
| Cheno-Am | Small Seed | 11 | 91.6% |
| Grasses | Small Seed | 11 | 91.6% |
| Acorn | Toxic Nut | 10 | 83.3% |
| Manzanita | Non-Toxic Pit | 9 | 75% |
| Phacelia | Small Seed | 9 | 75% |
| Prickly Pear | Fruit | 7 | 58.3% |
| Red Maids | Small Seed | 7 | 58.3% |
| Tarweed | Small Seed | 7 | 58.3% |
| Wild Cherry | Toxic Pit | 4 | 33.3% |
| Pine | Non-Toxic Nut | 2 | 16.6% |

Brodiaea occurs at all 12 of the domestic sites on Santa Cruz Island for which paleoethnobotanical data are available. Cheno-ams and grass seeds also have a high ubiquity value, occurring in 91.6% of sites. Acorn, although generally occurring in low densities, is

relatively ubiquitous, occurring at 83.3% of island sites despite higher processing costs. Manzanita berry pits and phacelia occur at 75% of sites, while prickly pear cactus fruit, red maids and tarweed seeds are present at 58.3% of sites. Surprisingly, wild cherry pits and pine nuts have low ubiquity values, present at only 33.3% and 16.6% of sites, respectively. Except for prickly pear cactus, all of these food plants were identified at the Diablo Valdez site.

Based on the broader trends in island plant foods, as well as the archaeobotanical data provided by the Diablo Valdez, Sunburst, and Brodiaea Ridge sites, I propose a revised ranking of the island plant food categories I initially ranked in Chapter 3, Table 3.4. This ranking still considers carbohydrate content more important than overall caloric value, as well as processing costs and seasonal availability, but it also takes into account the archaeobotanical data presented here and by previous researchers (Table 7.14). The revised scheme is similar to that presented in Table 3.4, but ranks small seeds above fruits, berries, and pits, and toxic nuts above non-toxic nuts. Geophytes continue to be ranked highest; brodiaea are phenomenally abundant and productive on the island, can be harvested nearly year-round, require little processing, and are well represented in all island archaeobotanical assemblages. Kelps and seaweeds have not yet been identified in the archaeobotanical assemblages, but their nearshore abundance, nutritional composition, and availability year round (between annuals and perennials) suggests they were probably an important food source. Small seeds are ranked third here, as they are rich in carbohydrates and well represented in island archaeobotanical assemblages. Cheno-ams and grasses are found at more sites than other small seeds overall. Although manzanita berry pits have a higher carbohydrate content than small seeds, they (and other fruits) are less well represented

Table 7.14. Revised Ranking of Island Plant Food Types Based on Carbohydrates, Seasonal Availability, Processing Costs, and Island Archaeobotanical Assemblages.

| Rank | Type | Example | Season of Harvest |
|---|---|---|---|
| 1 | Geophytes | brodiaea | all year |
| 2 | Kelps and Seaweeds | bull kelp, seaweed | all year |
| 3 | Small Seeds | cheno-am, grass | summer |
| 4 | Fruits, Berries, and Pits | manzanita, elderberry | summer |
| 5 | Leaves, Stems, and Stalks | clover, miner's lettuce | spring |
| 6 | Toxic Nuts/Pits | acorn, wild cherry pit | fall, late summer |
| 7 | Non-Toxic Nuts | pine, black walnut | fall |
| 8 | Aquatic Roots/Rhizomes | cattail | fall, spring |

in island sites than small seeds. This may very well be a product of preservation and processing bias, however. Leaves, stems, stalks, and flowers are ranked fifth, despite not being represented in the macrobotanical assemblage. Greens contain important vitamins and minerals, and some contain high amounts of carbohydrates as well. These greens would likely have been an important spring-time resource, some of which could have been stored for later use. Toxic nuts, including acorn and wild cherry pits, are ranked above non-toxic nuts (pine nuts and black walnut) because both acorn and wild cherry are much better represented in island archaeobotanical assemblages than pine nuts or walnuts, possibly indicating a cultural preference.

The small-seeded Bishop pine appears not to have been used much (if at all), although future paleoethnobotanical research may revise this assessment. Large-seeded pine nuts are occasionally identified on the island, and may have come from Santa Rosa Island or the mainland, but were apparently not a significant part of the diet. Black walnut was likely imported from the mainland, which increases the overall processing/transportation costs significantly. This is probably why it is not found more regularly in island deposits despite its

high protein and fatty acid content. Aquatic roots/rhizomes are ranked last, although they are not well represented in the macrobotanical assemblages.

While ranking plant foods on a broad scale is useful to archaeologists, important factors like plant community distributions and seasonal scheduling are ignored. Obviously, many of these plant foods are available only during a certain time of year, and the seasonal round should be considered. Leaves, stems, stalks, and flowers are found in most abundance during the spring, although some (i.e., brodiaea and cattail shoots) are also available in the fall. Small seeds, fruits and berries generally ripen in the summer, except for the winter-ripening toyon. Wild cherry pits were available in the late summer, and acorns and pine were available only in the fall. Both brodiaea corms and kelps/seaweeds are largely available for collection throughout the year. Considering the seasonal round then, plant food rankings should be expected to change seasonally. In general, the Island Chumash and their ancestors had access to an abundant and diverse array of plants that they used as food, medicine and tools.

**Summary**

In this chapter, I have demonstrated that island plant food resources were more diverse and abundant than previously thought, and that plant subsistence was remarkably unchanged for nearly 6,000 years at Diablo Valdez. The diversity of edible plants that occur on the island today far exceeds the diversity identified archaeologically, suggesting that many more food plants were available to the islanders than they chose to exploit or are preserved in the paleoethnobotanical record. Furthermore, the plant food remains identified most frequently on the island are consistently those that provide the most carbohydrates for

the lowest amount of effort (i.e., brodiaea corms), supporting the notion that ranking in terms of return rates based on carbohydrate content rather than caloric value is appropriate for the islands where fats from marine resources are plentiful. For instance, I expected to find remains of the locally abundant Bishop pine nut, but no archaeobotanical evidence for its use has been found on the islands, suggesting that the islanders chose to ignore this potential food source. Why pine nuts were ignored on the islands where they are important food resources elsewhere in California is likely two fold: First, the seeds of Bishop pine are small (6 mm) compared with gray, pinyon, or torrey pine seeds (~15 mm) and their closed cones require fire to open, increasing processing costs; Second, when assessed on a broader island-wide scale, archaeobotanical evidence of pine nuts (both large and small) is surprisingly low given their high caloric value. The processing costs of Bishop pine would probably not have been much higher than processing costs for the toxic acorn or wild cherry, both of which are well-represented in the assemblage and contain more carbohydrates than pine, supporting the idea that carbohydrate content of plant foods was the most important consideration in foraging decisions.

While the abundance of acorn and small seeds relative to brodiaea corms appears to increase later in time at Diablo Valdez, there is no significant change in plant foods through time when each taxon is assessed independently using density and standardized measures. The surprising lack of change seen at Diablo Valdez may or may not hold true for other areas of the island, but does point to a remarkable stability in island plant food resources. Not only is there no significant change through time in the densities or ratios to total plant weight for the primary plant foods recovered at Diablo Valdez, there is also no evidence for a significant expansion of the diet to include lower-ranked foods (e.g., Bishop pine nuts), even during

periods of presumed resource stress (e.g., the MCA). While people were living at Diablo Valdez, their plant food diet was largely the same for nearly 6,000 years, reflecting little change in the kinds and proportions of available plant foods in the site vicinity. The availability of various plant foods on the island that do not appear to have been exploited, combined with a lack of significant change or expansion of the diet at Diablo Valdez, may point to an island plant food resource base that was much more stable and productive than archaeologists have previously assumed.

# CHAPTER 8

# SYNTHESIS, CONCLUSIONS, AND FUTURE RESEARCH

In this dissertation, I set out to explore the significance of plants foods to the Island Chumash of western Santa Cruz Island through excavation and analysis of samples from three sites in upland and interior areas that contained bedrock mortars presumed to have been used in the processing of local or imported plant foods. There is a long history of analysis of faunal assemblages from Island Chumash sites, but comparatively little paleoethnobotanical research has been done, creating a large disparity in faunal vs. floral data that has led some researchers to postulate that plant foods were a major motivating factor behind cross-channel exchange networks and subsequently, sociopolitical complexity (Arnold 1987, 2001; Arnold and Martin 2014). In the preceding chapters, I have addressed this disparity by focusing on paleoethnobotanical and other archaeological remains from Santa Cruz Island sites with bedrock mortars. These sites provided a wealth of information about the use of plant foods by the Island Chumash during the past 6,000 years. All three of these sites are located well into the interior, in some of the most productive terrestrial areas on the island.

## Interior Site Types: Sunburst, Brodiaea Ridge, and Diablo Valdez

The three sites analyzed for this research provide important information for testing ideas about the use of plant foods and island interiors by the Island Chumash. Based on site types defined by Kennett et al. (2007:365), the sites investigated here appear to represent a range of interior site types: a logistical encampment (Sunburst); an interior residence (Brodiaea Ridge); and a village (Diablo Valdez).

The Sunburst site is most likely a logistical encampment, as occupation was relatively ephemeral beginning in the Transitional Period and into the Late Period, between about AD 1260 and 1500. Plant remains recovered from this site show a focus on manzanita berries and black sage seeds, both summer-ripening plant foods high in carbohydrates, probably procured largely from local chaparral habitats. Use of brodiaea corms and acorns is also evident, albeit in lower densities. Olivella bead manufacturing clearly occurred at this site, yet was most likely secondary to plant food procurement activities, as no raw materials (i.e., shells or chert) for bead manufacture could be procured from this locale.

Radiocarbon dates and the diversity of artifacts, faunal remains, and plant remains suggest that the Brodiaea Ridge site was probably an interior residence used for nearly 6,000 years. This interpretation is vague and broadly encompassing, however, and the function of the site may have varied through time. Regardless, the plant remains identified at Brodiaea Ridge suggest that a wider range of plant foods were deposited at this location compared with Sunburst, with a focus on grassland taxa including brodiaea corms and small seeds.

The Diablo Valdez site provides a high-resolution record of archaeological and paleoethnobotanical remains spanning nearly 6,000 years of occupation. The presence of house pits, human burials, roasting pits, and diverse floral, faunal, and artifactual assemblages suggests that the site may have served as a village during much of its occupation. The Middle Period is less well represented at the site than earlier or later time periods, suggesting a lower frequency and/or duration of occupation during this time—at least in the tested areas. The comparatively ephemeral use of this interior site during the Middle Period may correlate with a broader pattern of a shift to increased coastal settlement (see Kennett 2005; Perry and Glassow 2015), but occupation appears to have persisted longer into the

Middle Period than at most other known interior sites (~2330-2360 cal BP). The Diablo Valdez site may represent a secondary village site, similar to a primary village except that while isolated burials may be present, cemeteries are apparently absent (although identifying cemeteries often requires significant excavation). Kennett et al. (2007:356) described primary villages as those that were "clearly occupied for extended periods of time and served as central locations for a variety of economic and social activities. These sites are large, [and] contain deeply stratified or laterally extensive midden deposits…." The abundant marine and terrestrial resources identified at Diablo Valdez, combined with various domestic features, presence of human burials, and duration of occupation confirm it was an important location for nearly 6,000 years and likely used as a village during portions of this time span. At present, documented village sites are relatively rare in upland or interior areas on Santa Cruz Island, but surveys have been limited in such areas, and interior village sites similar to Diablo Valdez may not be uncommon in this area.

## Island Interiors and the Terrestrial Environment

### *The Use of Island Interiors through Time*

As emphasized earlier, island plant resources were more abundant and diverse prehistorically on the islands than archaeologists once thought, and the Island Chumash used a variety of local plants for food, medicine, and tools. As many of these plant resources are more abundant and diverse in island interiors, they are generally cited as the primary reason for moving away from the coast, in addition to other factors such as fresh water and raw materials (Kennett 2005; Kennett et al. 2007; Perry and Glassow 2015). People have been using the island interiors since they arrived ~13,000 years ago, when the northern islands

were connected as a single landmass known as Santarosae. Indeed, all Paleocoastal occupations documented on the islands today represent the vestiges of interior Paleocoastal settlement. As noted by Erlandson (2013:107):

> During the Last Glacial Maximum, Santarosae was nearly three times as large as the aggregate landmass of the islands today and is estimated to have lost roughly 70 percent of its land area since that time (Kennett et al. 2008:2533). This poses major challenges for archaeologists trying to locate terminal Pleistocene sites because the ancient shorelines and most of the coastal lowlands where Paleocoastal peoples probably spent most of their time have been lost to or obscured by sea level rise and coastal erosion. All the known early Paleocoastal sites (>11,000 cal BP) appear to have been located at least two kilometers from the terminal Pleistocene coastline and several were considerably further from the shore.

As sea levels rose, the terrestrial environment changed as the islands became increasingly inundated, smaller, and separated until ca. 7000 to 6000 years ago, when sea level rise slowed dramatically. It was only after this time that the island interiors we see today are more or less comparable to those experienced by island people, at least in terms of overall extent. It is not surprising then, that there is a larger number of "interior" sites that post-date the stabilization of sea levels, as population densities surely increased with the significant loss of landmass. For Santa Cruz Island, Perry and Glassow (2015:200) noted that "most interior sites (n=28) date to between 3800 and 1000 BC [5800 and 3000 BP], correlating with Orr's (1968:99-100, 179-180) 'Highlander Phase' on Santa Rosa Island …."

Use of the interior continued after this time, although both Kennett (2005:169) and Perry and Glassow (2015) noted a decline in interior settlement beginning around 3000 BP. After around 3,000 years ago, there was an apparent shift towards coastal settlement, resulting in a decline in residential mobility and reduction in foraging range, suggesting a change in the way plant foods were collected (Kennett 2005:169). The Diablo Valdez site was occupied most intensively from 5,800 through around 3,000 years ago, but the site was

used during the first half of the Middle Period (~2330-2360 BP) as well. After this time, it appears not to have been occupied again until the Transitional Period, although additional excavation and $^{14}C$ dating might close this gap. By the Late Period, the presence of house pits and diverse floral, faunal, and artifact assemblages again suggest a relatively intensive occupation.

Island-wide, an increase in the number of sites dating to later in time, after around AD 500 (1450 BP), is seen in both interior and coastal areas, a pattern also apparent on the other northern islands. The abrupt increase in sites is often cited as evidence for an increase in population around this time (Erlandson et al. 2001; Kennett 2005; Perry and Glassow 2015). Island people apparently congregated in large coastal villages later in time, where craft specialization and participation in the interregional trade networks became increasingly important after the Transitional Period (AD 1150-1250), when extreme drought occurred during the Medieval Climatic Anomaly (Arnold 2001; Jones et al. 1999).

*The Terrestrial Island Environment Through Time*

Evaluating the terrestrial environment and extent of episodic drought through time is complex and largely based on pollen records (Anderson et al. 2010; Rick et al. 2014) as well as inferences derived from the marine environment (Kennett et al. 2007). Rick et al. (2014:683) use pollen and charcoal records from Soledad Pond and Abalone Rocks Marsh on Santa Rosa Island to show that:

> By approximately 11,800 years ago, pine stands were largely replaced by coastal sage scrub and herbs or grassland as the climate warmed and became increasingly dry, particularly after approximately 9150 years ago.... By about 6900 years ago, both Santa Rosa sites suggest that perennial herbs and grasses were the dominant vegetation type.

As grasslands became more prevalent on the islands through the Holocene, the relationship between people and plants changed as well. An increase in wood charcoal, suggesting greater fire frequencies, is evident in the pollen cores beginning around 3,500 years ago and may be attributed to increased landscape burning by the Island Chumash (Anderson et al. 2010; Rick et al. 2014), an ethnohistorically documented practice on the adjacent mainland and elsewhere in California (Cuthrell et al. 2012; Timbrook et al. 1982). Cuthrell et al. (2012:162) argue that in coastal central California "anthropogenic burning … will tend to create and maintain grassland vegetation communities, in contrast to those communities supported by natural fire regimes (shrublands and conifer forests)." In addition to increasing the overall extent of grasslands, anthropogenic burning also encourages the growth of various economic plants, many of which occur in grasslands. These "fire following" plants were often important foods, including many taxa documented in island assemblages such as brodiaea, grasses, cheno-ams, phacelia, clover, red maids, etc. (Timbrook et al. 1982). The archaeobotanical data from Diablo Valdez support the notion that anthropogenic burning occurred on Santa Cruz Island in the past, with grassland taxa dominating (65-93%) the paleoethnobotanical assemblage for the past 6,000 years. Edible grassland taxa (especially brodiaea, grasses, cheno-ams) also tend to dominate the archaeobotanical assemblages from other island sites, some of which were occupied as much as 10,000 years ago (Reddy and Erlandson 2012; Watts et al. 2015).

Changes in the marine environment based on oxygen isotopic signatures of foraminifera in sediments from the Santa Barbara Basin have also been used to infer changes in the terrestrial environment (Kennett and Kennett 2000; Pisias 1978). Kennett et al. (2007) documented intervals of cool and warm sea surface temperatures, combined with isotopic

signatures of foraminifera (vertical mixing), to infer overall marine productivity through time. They suggested that marine productivity was highest between 7,500-6,800 and 6,500-5,900 years ago, with reduced productivity between 6,800-6,500 and 5,900-3,900 years ago. Recognizing that the interrelationship between marine and terrestrial climatic conditions are complex, and drawing from paleoenvironmental and precipitation data from western North America more broadly, Kennett et al. (2007:356) suggested that the coolest SST intervals appear to be associated with the driest intervals in interior California and Nevada. A similar pattern was identified in later paleoenvironmental records from the coastal ranges of southern California, corresponding to the Medieval Climatic Anomaly (MCA) between 1,200 and 600 years ago (AD 800 and 1400) (Kennett et al. 2007:355).

These intervals of a cool and productive marine environment juxtaposed with a warm, dry terrestrial environment should be visible in the archaeological record if they resulted in significantly lowered productivity of terrestrial resources and/or freshwater availability to the island inhabitants. During these earlier intervals of cold SSTs during the Middle Holocene (6,300-5,800 years ago), Kennett et al. (2007:361) suggested that while there was an emphasis on marine resources for subsistence, "shortfalls in terrestrial resource availability and drinking water minimally impacted northern Channel Islanders because of their low populations relative to resource availability." Essentially, the supposed dry conditions of the terrestrial environment during the period of cold SSTs between 6,300 and 5,800 years ago did not result in measureable terrestrial resource stress on island populations, due to low population densities (Kennett 2007).

Later in time, however, the prolonged warm, dry terrestrial and cold, productive marine conditions during the MCA (AD 800-1400) have been cited by various researchers as

being a prime mover in the solidification of the sociopolitical and economic complexity seen during and after this time (Arnold 1987, 2001; Arnold and Martin 2014; Glassow et al. 2007; Jones et al. 1999; Kennett and Kennett 2000; Stine 1994; but see Gamble 2005). Arnold and Martin (2014) identified an increase in the relative proportion of prickly pear and manzanita berries during the Transitional Period, compared with the Middle and Late Periods, although larger sample sizes using various quantitative measures would be useful in testing these variations for significance.

The archaeological and paleoethnobotanical data I have presented here are used to test hypotheses about change in plant food uses, environmental stress, and plant resources in the regional trade networks before, during, and after the Medieval Climatic Anomaly. As additional paleoethnobotanical research is conducted at more island sites, and more paleoethnobotanical data are available for quantitative comparison, our understanding of these issues will become more refined.

### Evaluating Environmental Stress, Island Plant Use, and Plants in Regional Trade Networks through Time on Santa Cruz Island

I developed two hypotheses to address various issues related to the role of terrestrial plants in Island Chumash subsistence, including: 1) the importance of plant foods in Island Chumash diets relative to marine resources; 2) the effects of environmental stressors such as drought on island plant foods; 3) changes in plant food diet breadth; and, 4) the extent to which plant foods were incorporated into the regional trade networks. The majority of the data I use to address these research issues come from the Diablo Valdez site, as occupation at this deeply stratified site spans 6,000 years contains well defined components rich in both

plant and animal remains, and allows for analysis of long-term subsistence trends at an interior village.

Hypothesis 1. Because carbohydrates found mostly in plant foods are an important component of a well-rounded diet rich in animal proteins (Erlandson 1988; Noli and Avery 1988), highly-ranked plant resources such as geophytes and non-toxic nuts/pits are expected to supplement the marine diet, even during periods of high marine productivity. If periods of warmer seawater temperatures reduced the productivity of marine resources significantly, the expansion of diet breadth to include lower-ranked plant resources such as toxic nuts, small seeds, and aquatic rhizomes is expected.

Hypothesis 2. If the regional exchange network linking the islands and mainland, especially after the emergence of the *tomol* around AD 500 and even more so during the height of the Medieval Climatic Anomaly (ca. AD 1000-1300), resulted in the importation of significant amounts of plant foods from the mainland, as suggested by some archaeologists and ethnohistoric records, these plant foods should be represented in the archaeobotanical assemblage. Locally-obtained island plant foods should continue to persist, but with a focus on highly-ranked resources (i.e., geophytes), which should be targeted regardless of variation in marine productivity or changes in cross-channel transport efficiency (the *tomol*). If the Medieval Climatic Anomaly resulted in significant terrestrial environmental stress on the islands, we should see an increase in mainland plant foods and/or a significant widening of diet breadth to include lower-ranked plant foods that have higher processing costs.

The first hypothesis predicted changes in plant food diet breadth corresponding to changes in the productivity of the marine environment, whereas the second hypothesis predicted changes in plant food diet breadth corresponding to terrestrial environmental stressors, such as the prolonged drought during the MCA. Positing an extension of diet breadth, the second hypothesis also includes predictions about the importation of plant foods from the mainland. *Hypothesis 1* predicted that highly ranked plant foods based on caloric return rates (i.e., geophytes and non-toxic nuts/pits) were expected to supplement the marine diet, even during periods of high marine productivity. Diet breadth was expected to expand to include lower-ranked resources (i.e., toxic nuts and small seeds) when marine productivity was lower. *Hypothesis 2* predicted that if the MCA resulted in significant terrestrial environmental stress on the islands, we should see an expansion of diet breadth to include lower-ranked (kcal/hr) island plant foods as well as an increase in mainland plant food imports.

*Optimal Island Plant Foods*

As discussed in Chapters 3 and 7, ranking island plant foods in terms of "optimality" is complex and regionally variable. The initial plant food rankings used to develop the hypotheses that drove my research were based on caloric return rates derived from gathering experiments conducted in Central California and Great Basin plant communities (Simms 1987; Wohlgemuth 2010). As I argued in Chapter 3 and evaluated in Chapter 7, carbohydrates are probably a more appropriate currency for ranking plant foods in island contexts, where fat and protein are readily available from marine resources, and appears to be supported by the available island paleoethnobotanical data.

For example, large seeded pine nuts, which are a highly ranked plant food in other areas of California (Farris 1993; Wohlgemuth 2010), are absent from Brodiaea Ridge and Sunburst and only one large pine seed was identified at Diablo Valdez, reflecting a pattern that appears to be common at Santa Cruz Island sites (see Table 7.13). Furthermore, there is no evidence in the island archaeobotanical record that the locally abundant small-seeded Bishop pine was used as a food source. While evidence for the use of Bishop pine seeds on the islands may become more visible with additional research, it appears not to have been an important food source. The local Bishop pine produces small, closed serotinous cones (which open post-fire), from which the small seeds are more difficult to extract than from other pine species. However, all pine seeds are generally high in fat and protein compared with carbohydrates (Farris 1993; Gilliland 1985), and ranking plants based on carbohydrate content puts pine seeds, large and small, low on the list (see Tables 3.3 and 7.14).

A complicating factor in ranking all plant foods, whether calories, carbohydrates, or another proxy is used, is seasonal availability. Some plant (and marine algal) foods are available nearly year-round (brodiaea, kelps/seaweeds), while others are available during only one season (fruits, small seeds, manzanita, acorns). Storage of plant foods throughout the year mitigates seasonal fluctuations in the plant food base, however, and archaeobotanical data from sites where plant foods were used and possibly stored provide the best resolution for long-term subsistence strategies. While no direct evidence for storage was identified at Diablo Valdez, it is probable that storage did occur. Archaeobotanical data from logistical encampments are more likely to reflect seasonal or targeted procurement strategies, as seen at the Sunburst site where manzanita and sage seeds dominate the assemblage. If significant changes in available terrestrial resources occurred on the island due to environmental

stressors, a shift in diet breadth should be visible in the archaeobotanical data at sites used as residential bases, where resources would have been collected from a broader area during multiple seasons.

*Plant Food Diet Breadth through Time on Santa Cruz Island*

General trends in plant food diet breadth through time at Diablo Valdez show patterns of long-term subsistence strategies appropriate for addressing the hypotheses driving my research. Principally, I was unable to identify any significant change in diet breadth for nearly 6,000 years of occupation at the Diablo Valdez site based on paleoethnobotanical data and ranking plants in terms of carbohydrates and processing costs. There appears to be no statistically significant change in the density or ratio to total plant weight of brodiaea corms, manzanita berry pits, small seeds, or acorns through time, including periods of lowered marine productivity. While there is a measureable increase in the proportion of small seeds and acorn nutshell relative to geophytes later in time, the lack of substantial change in these plant food taxa when analyzed independently indicates that the increase is not significant. Surprisingly, diversity analysis of the plant remains at Diablo Valdez through time also shows no significant change in overall diversity of edible plants.

Therefore, Hypothesis 1 must be rejected, and I conclude that high-ranking plant foods were consistently important through time at Diablo Valdez, regardless of changes in marine productivity. Marine resources were important at all island habitation sites through time, regardless of distance from the coast (Perry and Glassow 2015). Marine resources were clearly important at the Diablo Valdez site as well, with very large amounts of shellfish (mostly California mussel) transported to the site, in addition to sea mammals, birds, and fish.

Analysis of shell to bone weight ratios shows that shellfish was the most significant source of protein through time, supplemented by fish and birds that also remain consistent through time. Sea mammal shows a statistically significant increase (proportionate to shellfish) during the Late Period compared with the Early Period. This may reflect differential processing decisions, increased trade with islanders further to the west, or a change in technology that allowed for intensified hunting (e.g., the bow and arrow, the *tomol*). That sea mammals (typically considered highly ranked) are the only food remain that show any change (an increase) though time, however, further points to a relatively stable marine and terrestrial resource base used by the inhabitants of Diablo Valdez for 6,000 years.

*Evidence for Mainland Plant Foods and the Role of Interior Sites in Craft Specialization*

The stable and consistent use of plant foods through time suggests that the environmental changes that purportedly resulted in terrestrial resource stress during the MCA were not as significant at the Diablo Valdez site as expected. There is no evidence for an increase in mainland plant foods during or after the MCA, as has been suggested by previous researchers based on data from other coastal island sites (Arnold 2001; Arnold and L. Martin 2014; L. Martin 2010). Mainland plant resources (e.g., large-seeded pine and California wax myrtle) do occur in very low densities and during various time periods at Diablo Valdez, indicating that plant resources were included in the regional trade networks through time, at least to some extent. Therefore, Hypothesis 2 must also be rejected, as no evidence for significant terrestrial environmental stress, manifested as a change in diet breadth either with regard to island plant foods or increased amounts of imported mainland plant foods, was identified at Diablo Valdez.

No unequivocal mainland plant remains were identified at either Brodiaea Ridge or Sunburst. However, occupants of the Sunburst site were engaged in craft specialization in the form of olivella bead manufacture, apparently bringing olivella shells and chert microdrills to the site for the manufacture of beads while procuring plant food resources. Curiously, while the artifacts from Late Period deposits at Diablo Valdez are largely typical of those in island assemblages, evidence for participation in the larger bead making/craft specialization, so obvious at other island village sites is lacking here. Bead making detritus, microdrills, and olivella beads are present at Diablo Valdez, but as with artifacts from earlier time periods, they are not abundant. Compared with the ephemeral Sunburst site, where 42 microdrills/blades were recovered, only 22 TDR microdrills/blades were recovered from the much more substantial Late Period deposits at Diablo Valdez. Low-level bead manufacture occurred at Brodiaea Ridge as well, although the mixed deposits limit our ability to see temporal trends. Overall, intensive bead manufacturing did occur at some interior sites, but was not observed at Diablo Valdez, even though it has been well documented at other Transitional and Late Period island village sites (see Arnold 2001; Arnold and Graesch 2001; Graesch 2004; Peterson 1994).

**Groundstone Technology and Plant Food Processing**

The groundstone technology present at all three sites (including bedrock mortars and portable stone bowls at Brodiaea Ridge and Diablo Valdez) provided the first indication that plant foods were probably processed at these sites. The macrobotanical assemblages demonstrate that small seeds, manzanita berry pits, acorns, and other plant foods were all processed at these sites, presumably using the bedrock mortars and/or portable stone bowls

present onsite. A single pine starch grain was also recovered from a portable stone mortar at Diablo Valdez, despite testing several of the portable mortar fragments from Diablo Valdez and Brodiaea Ridge (Kristin Hoppa, personal communication 2015). The macro- and micro-botanical data from these sites, then, suggest that a wide variety of plant foods were being processed in these bedrock and portable stone mortars. Other non-plant resources may have been processed in these mortars as well.

The island paleoethnobotanical and artifactual assemblages do not support the prevailing assumptions in California that milling technology is associated with small seed processing and mortars with acorns or acorn intensification. The importance of small seeds in island assemblages within the last 6,000 years suggests that small seed processing occurred on the islands, largely in the absence of milling technology. Small seeds also appear to have been important earlier in time during the Millingstone Horizon period on the mainland (Reddy and Erlandson 2012), although additional island archaeobotanical work from these earlier periods is needed. Furthermore, the prevalence of bedrock and portable stone mortars after around 6,000 years ago does not appear to coincide with substantial or intensive acorn processing on the islands. Acorns were certainly used on the islands, but occur only in low densities and low plant weight ratios that remain consistent through time. Rather, it appears as though stone mortars on the islands (bedrock or portable) were most likely used to process a variety of plant foods, and possibly non-plant resources as well. Unrelated to milling or mortar technology, the preponderance of digging stick weights on the islands supports the archaeobotanical data showing geophytes (and brodiaea corms in particular) were a significant island food source throughout the Holocene.

## Re-Evaluating the Marginality of Terrestrial Resources on Santa Cruz Island

### *Island Plant Diversity and Abundance*

The stability of the subsistence resource base seen at the Diablo Valdez site through time—including various plant foods, shellfish, bird, and fish remains, with an increase in sea mammal remains during the Late Period—is significant to our understanding of Island Chumash lifeways. Diversity of available native food and medicinal plants, as well as plants useful for making tools, is high on Santa Cruz Island today and would have been even more diverse prior to the historic ranching period. Although the overall *diversity* of available plant resources on the islands is lower when compared to the mainland, the *abundance* of various high-ranking plant resources may be significantly greater on the islands in the absence of herbivorous predators such as gophers, moles, ground squirrels, deer, and rabbits. Even on San Miguel Island, which has lower overall plant diversity (206 species) compared with Santa Cruz (493 species), edible plants can be found in great abundance, including brodiaea, dudleya, and giant coreopsis, which has large edible seeds as well as fleshy edible stems. On Santa Cruz Island, moreover, there are at least 10 species of oak trees present today in extensive oak woodland habitats, raising questions about why the Island Chumash would import acorns from the mainland to supplement island plant foods (Gill and Erlandson 2014).

As Chanel Island vegetation communities recover from more than a century of overgrazing, it has become clear that the phenomenally abundant geophyte resources that occur on the islands are significantly larger and denser than their mainland counterparts. The brodiaeas are particularly well represented in the archaeobotanical record for the islands, used for at least the last 10,000 years (Gill 2013; Reddy and Erlandson 2012; Thakar 2014; Watts et al. 2015; see Chapter 3), and they can be harvested during multiple seasons (Gill

2014; see Chapter 7). Other edible geophytes occur on the islands as well, including mariposa lily, Humboldt lily, sword fern, shooting star, jepsonia, wild onion, and others (see Appendix A). The diversity and unparalleled abundance of island geophyte resources would have provided easily procurable and substantial carbohydrates for the Island Chumash and their ancestors. Combined with the diverse and abundant edible marine plants and algae surrounding the islands, geophytes and other highly-ranked island plant foods provided a stable and abundant resource base that appears to have been more resilient to environmental fluctuations than previously thought. The importance of edible geophytes in concert with shellfish (and other marine resources) to subsistence regimes in coastal areas has been noted elsewhere in the world, with the earliest direct evidence dating as far back as 22,000 years ago in South Africa (Deacon and Deacon 1999; Deacon 1984; Klein 1975, 1977; Opperman and Heydenrych 1990; Parkington and Poppenpoel 1971). Indeed, Marean (2010a, 2010b) has suggested that Middle Stone Age exploitation of shellfish and geophytes was significant in the development of anatomically modern humans. The combination of geophytes, other terrestrial plants, and marine algae with marine faunal resources provided the Island Chumash with ample food, medicine, and raw materials that were more stable than previously assumed.

*Terrestrial Drought and Freshwater Availability on the Islands*

As described above, the two distinct intervals of colder SSTs and dry terrestrial conditions during the Middle (6300-5800 BP) and Late Holocene (1500-500 BP, including the MCA) do not appear to be associated with extreme terrestrial environmental stress at the Diablo Valdez site. No evidence for a significant change in diet breadth was identified at

Diablo Valdez through time, nor was there evidence for an increase in the importation of mainland plant resources later in time. However, it is possible that the environmental context of this site allowed for greater access to fresh water (for both people and plants) from coastal fog (and orographic lift) compared with other areas of the island. Furthermore, coastal fog becomes even denser further west along the island chain, with San Miguel Island receiving substantial amounts of fresh water from fog drip (see Chapter 2). As the islands revegetate during the post-ranching period, the quantity and importance of fog-drip to island hydrology is becoming increasingly apparent.

The potential role of fog drip to overall fresh water availability on the islands may have been very important, especially during periods of lower precipitation. Intervals of cooler SSTs, generally resulting in a drier terrestrial environment within a larger regional context, may actually have increased levels of coastal fog formation around the islands. This coastal fog may have played a significant role in mitigating the effects of drought, presumably during periods of measurably cooler SSTs, and possibly over long periods of time such as the MCA. Paleoethnobotanical remains may be able to inform us about overall plant productivity and freshwater availability in various areas when data from archaeological sites are compared spatially and temporally. Notably, in the third and fourth years of a historic drought affecting California from 2012 to 2015, geophyte populations on the northern Channel Islands continued to be extraordinarily abundant and productive, possibly due to the significant effects of fog drip and reduced evapotranspiration.

*Mainland Plants in Island Sites: Dietary Necessities or Luxury Goods?*

Distinguishing between mainland versus island archaeobotanical remains is inherently difficult, as both places harbor very similar native California plants. Furthermore, the historical processes of overgrazing, erosion, and introduction of non-native species affected both the mainland and islands, although the effects of overgrazing were much more pronounced on the islands (see Chapter 2). An unknown number of plant species were extirpated from the islands during this period, while many mainland counterparts survived. Therefore, we cannot assume that a plant resource identified in island archaeobotanical assemblages, absent from the islands today (or historically) but present on the mainland, was not present on the islands in the past. Understanding the vulnerabilities of various plant types to overgrazing is important for interpreting archaeobotanical data. For example, the presence of western sea purslane in coastal island sites has been interpreted as evidence for cross-channel trade of this plant resource, as it does not occur on Santa Cruz Island today (Arnold and L. Martin 2014; S. Martin and Popper 2001). Western sea purslane has edible greens and grows in saline habitats adjacent to the coast or salt marshes on the adjacent mainland. It occurs naturally on San Clemente Island (Junak et al. 2003), however, and its classification as a mainland taxon seems tenuous at this point, given its vulnerability to grazing livestock and subsequent habitat loss. Rather, we should focus on plant resources that have longer life-spans and are more difficult to extirpate, such as trees, to assess the role of plants in cross-channel trade prehistorically.

As discussed in more detail in Chapter 3, acorns have been cited as one such important trade item from the mainland (Arnold 2001; Fauvelle 2013). The diversity and abundance of oaks on Santa Cruz today is high, with 10 species (and an additional

subspecies) known to exist. Timbrook (1993) suggested that this unusual diversity may have been the result of cross-channel exchange of acorns. Despite the abundance and diversity of oaks on Santa Cruz Island today, there is evidence only for low-level use of acorns as a food source through time, with very low densities of acorn nutshell identified in early, middle, and late Holocene deposits. Fauvelle (2013) used experimental approaches to evaluate whether acorns or processed acorn flour were an important commodity traded from the mainland to the islands, based on *tomol* storage capacities and volumes of acorn in various stages of preparation (e.g., whole, shelled, coarsely ground, and finely ground flour). While he suggests that shelled acorns would have been the most efficient in cross-channel transport, he ultimately concludes that acorns would not have been an economical import from the mainland. Furthermore, if significant amounts of shelled acorns were being imported from the mainland, we should expect to find acorn nutmeats in island archaeobotanical assemblages. Only two examples of acorn nutmeats have been identified in the macrobotanical assemblages from Santa Cruz Island, present in Late Period deposits at Morse Point (SCRI-192) (S. Martin and Popper 2001). No acorn nutshell was identified at this site, suggesting that these remains represent shelled acorns imported from the mainland, or local acorns that were processed elsewhere. Nevertheless, as ethnohistorical accounts imply, the exchange of acorns across the channel may have occurred occasionally, but there is little current evidence on the islands to suggest this was a significant subsistence endeavor, or that such exchange changed much through time (see Gill and Erlandson 2014). Future archaeobotanical research should help to refine and elucidate our understanding of acorn use and exchange on the islands. Determining whether acorns came from mainland or island stands is inherently problematic, however, and acorns are therefore not a very good proxy for

evaluating regional exchange of plant resources. Other tree resources may prove more useful in this regard.

Black walnut has been found at two Santa Cruz Island sites (SCRI-191, -823) (see Chapter 3; S. Martin and Popper 2001; Thakar 2014), and large-seeded or thick-shelled pine nuts (i.e., not the local Bishop Pine) are now known from three sites (SCRI-191, -333, -619/620) (Lynn Gamble, personal communication 2014; S. Martin and Popper 2001). Both of these plant foods may have been imported from the mainland—although large, thick-shelled pine nuts could have come from Torrey pines on Santa Rosa Island—neither would easily have been extirpated historically and both were considered important food sources, ranked highly in other areas of California (Farris 1993; Wohlgemuth 2010). Both walnut and pine are generally comparable in nutritional content: gray pine (*P. coulteri*) nuts contain 25% protein, 49.4% fat, and 17.5% carbohydrates, whereas black walnuts (*J. nigra*) contain 20.5% protein, 59.3% fat, and 14.8% carbohydrates (Farris 1993). Transporting plant foods across the Santa Barbara Channel would increase their net procurement costs significantly, but these fat-rich mainland plant foods may have been important on the islands during times of resource stress. Therefore, if mainland plant foods were an important dietary supplement to the island plant food resource base, we should expect to see evidence of their use in island assemblages after the development of the tomol, with an increase in their import during periods of terrestrial environmental stress, including the MCA. From the paleoethnobotanical data now available from Santa Cruz Island, these mainland plant foods do not appear to have been particularly important, nor do they appear to increase in frequency later in time or during drought periods.

The presence of California wax myrtle in Late Period deposits at Diablo Valdez may provide an alternative perspective on the importation of plants foods from the mainland. As discussed in Chapter 7, the fragrant leaves and seeds of wax myrtle were used as a spice in cooking, tea was made from the bark, and the leaves were sometimes used as a substitute for tobacco (Austin 2004:767-769). Wax myrtle did grow on the Channel Islands during the Pleistocene, but it is unclear when it disappeared. However, the seeds were identified only in Late Period deposits at Diablo Valdez, which may suggest it was not as easily accessible earlier in time. If wax myrtle was traded from the mainland, it certainly was not for its caloric (or carbohydrate) content. Rather, it may have been considered a luxury good, given its use as a spice and the high transportation costs across the Santa Barbara Channel. In this light, black walnut and large-seeded and/or thick-shelled pine nuts might also be considered luxury goods rather than as a necessary supplement to island plant foods. This would help explain both the low density and number of sites overall in which these plant remains occur.

In general, given the abundance of geophytes, other edible plants, and marine algae on the Channel Islands, it seems increasingly unlikely that mainland plant foods were imported to the islands out of dietary or subsistence necessity, even during periods of environmental stress. Rather, they may have occasionally been imported as luxury goods that added to the diversity of plant foods available to the islanders.

**Conclusions**

In re-evaluating the long-perceived terrestrial marginality of Santa Cruz and the other Channel Islands, it appears that the islands actually may have provided *optimal* terrestrial plant resources for island people compared with the adjacent mainland. Given the lack of

herbivores on the islands, geophytes appear to have been significantly more abundant on the islands compared with the mainland, a pattern that may have translated to other plant foods (i.e., leafy greens, small seeds, etc.) as well. Kelps and seaweeds are also more diverse and abundant around the islands than along the mainland coast, providing an entirely separate source of carbohydrates, vitamins, and minerals and increasing the overall stability of the entire system. Freshwater sources may also have been considerably more abundant than previously assumed, especially when the contribution of fog water is considered. These factors, combined with diverse and abundant marine faunal resources, point to an extraordinarily rich and stable island resource base. If the islands were, in fact, better suited to deal with terrestrial resource stress and drought than the adjacent mainland, particularly given fog patterns, the cross-channel exchange of plant foods from the mainland was probably not the driving force behind the Transitional and Late Period changes in sociopolitical complexity, craft specialization, and expansion of the regional exchange networks. Rather, luxury goods (spices, high-fat nuts) and value-added items such as arrows, baskets, comals/ollas, etc. (Gill and Erlandson 2014; King 1976), in exchange for olivella shell bead money, may have been a more significant motivating factor.

**Future Research Directions**

Ultimately, some of the ideas and questions I have presented in this dissertation will be resolved only through the collection and analysis of additional archaeological and paleoethnobotanical data. In this final section, I suggest some additional avenues of research that will continue to refine our understanding of the role of plants and marine algae in Island

Chumash lifeways, which in turn has significant implications for sociopolitical complexity and regional exchange.

*Archaeological Survey*

While systematic archaeological survey has been conducted in many areas of the islands over the years, significant gaps remain. Continued systematic archaeological survey work is warranted to document, radiocarbon date, and assess sites, important for refining our understanding of island settlement and subsistence patterns. Some areas of Santa Cruz Island have been well documented, but there are many other areas that have never been systematically documented by archaeologists. The rugged western/central northern side of Santa Cruz is one of these areas, although systematic survey work along the northwestern coast has revealed numerous sites showing coastal occupation occurred for at least 9,000 years (Erlandson et al. 2015; Rick et al. 2014). Archaeological survey on the northern side of the island, and particularly in more interior settings, is necessary to assess how the Diablo Valdez site fits within a broader context and whether comparable sites are located in these adjacent upland areas. The terrain is rugged, however, with steep canyons and high, sheer cliffs making systematic survey difficult. Nevertheless, the northern coast remains much less well documented than other coastal areas, such as the west end, and may contain additional surprises.

*Paleoethnobotanical Analyses*

The subsistence patterns of stability in both marine and terrestrial resources identified at Diablo Valdez may or may not be similar at sites elsewhere on the island. Essential to

examining long-term subsistence within a broader island context, the Diablo Valdez data need to be compared with additional paleoethnobotanical data from other sites, as well as from earlier time periods at sites where paleoethnobotanical data from later periods are already available (Gummerman 1992; S. Martin and Popper 2001; L. Martin 2013; Thakar 2014). Site location (interior vs. coastal, northern vs. southern, eastern vs. western) and site type (village vs. interior residence vs. logistical camp) were likely significant factors in differential plant procurement, processing, and consumption decisions through time. Paleoethnobotanical analyses are crucial for addressing these and other questions.

The incorporation of macrobotanical analyses with other types of paleoethnobotanical analyses will be important in the future. Starch and phytolith residues on ground stone artifacts can provide valuable information about plant processing decisions, as well as the use of plants that are not typically well preserved in macrobotanical assemblages due to differential processing methods. Kristin Hoppa (UC Santa Barbara) is currently addressing these issues, using a combination of macro- and microbotanical data from various interior Santa Cruz Island sites, and preliminary results are promising. Allison Jaqua (UC Santa Barbara) is currently working on wood charcoal identification from sites on all the northern Channel Islands. Her research will provide valuable data on which types of trees/shrubs/driftwood were used as fuel, and how such uses may have varied through space and time. Furthermore, differential access to different quality fuel sources may elucidate patterns of sociopolitical status and organization at the household level. As various avenues of additional paleoethnobotanical research continue on the Channel Islands, we will continue to gain a more holistic understanding of Island Chumash subsistence.

*Experimental Plant Research*

Additional experimental research is needed for testing ideas about island plant food rankings and diet breadth, as well as seasonality, procurement locations, and the effects of managing various plant resources using native techniques within island plant communities. To address plant rankings and diet breadth, nutritional analyses of various plant foods should be done, as there may be important differences between island plants and their mainland counterparts. Updated return rate data specific to the islands should be collected and compared with return rate data from the Great Basin (Simms 1987), as plant food yields on the islands will almost certainly be significantly different than those in the Great Basin. Experiments with various types of island plants may further elucidate the potential of seasonal harvest times as well. The seasonal observations of modern brodiaea corms, used to infer season of harvest from archaeobotanical corms (Gill 2014; see Chapter 7), were monitored over a period of four years at the same location. While these observations were casual in nature, they ultimately proved significant in identifying a second season of harvest not recorded ethnohistorically. Careful observations of other island plants may provide similarly surprising clues in this regard. As the islands continue to recover from the ranching era, important plant procurement locations may become more apparent. The potential contribution of fog drip in upland locations and its effects on local hydrology and plant communities, for instance, may help explain the locations of certain interior/upland archaeological sites.

Finally, the collection and analysis of paleoethnobotanical data within the framework of historical ecology has the potential to aid conservation and restoration efforts for terrestrial plant communities on the Channel Islands. Long-term experiments using native procurement

and landscape management techniques may have important implications for ecologists, botanists, archaeologists, and archaeobotanists alike (Anderson 2005). Incorporating native management practices in modern restoration efforts may help promote native and endemic plant taxa in surprising ways. Of course, some native management practices (e.g., anthropogenic burning) present very real challenges to land managers and may not be practical in many situations. However, these techniques may ultimately be important for future restoration efforts of native island plants that have co-evolved with people for at least the past 13,000 years. For now, however, the recovery of Channel Island plant communities after more than a century of overgrazing and severe erosion is fundamentally changing our notions of the productivity of island plant foods and the lifeways of the Island Chumash people who depended on them for millennia.

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APPENDIX A

SANTA CRUZ ISLAND NATIVE PLANT GENERA AND ETHNOBOTANICAL USES

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| ***Ferns and Fern Allies*** | | | | | | |
| **BLECHNACEAE** | **Chain Fern Family** | | | | | |
| *Woodwardia* | giant chain fern | 1 | | | | |
| **DENNSTAEDTIACEAE** | **Bracken Fern Family** | | | | | |
| *Pteridium* | western bracken fern | 1 | Gr | X | X | X |
| **DRYOPTERIDACEAE** | **Wood Fern Family** | | | | | |
| *Athyrium* | western lady fern | 1 | | | | |
| *Cystopteris* | fragile fern | 1 | | | | |
| *Dryopteris* | wood fern | 1 | | X | | X |
| *Polystichum* | western sword fern | 1 | Ge | | | |
| **EQUISETACEAE** | **Horsetail Family** | | | | | |
| *Equisetum* | scouring rush | 3 | | X | X | X |
| **POLYPODIACEAE** | **Polypody Family** | | | | | |
| *Polypodium* | California polypody | 2 | | X | | X[2] |
| **PTERIDACEAE** | **Maiden Hair Family** | | | | | |
| *Adiantum* | maidenhair | 3 | | X | X | X |
| *Aspiotis* | California lace fern | 1 | | | | |
| *Cheilanthes* | lip fern | 2 | | | | |
| *Pellaea* | coffee fern | 2 | | X | | X |
| *Pentagramma* | gold-black fern | 2 | | X | | X |
| **SELAGINELLACEAE** | **Spike Moss Family** | | | | | |
| *Selaginella* | bushy spike-moss | 1 | | | | |
| | | | | | | |
| ***Conifers*** | | | | | | |
| **PINACEAE** | **Pine Family** | | | | | |
| *Pinus* | pine | 2 | N | | X | X |
| | | | | | | |
| ***Diocotyledonous Flowering Plants*** | | | | | | |
| **ACERACEAE** | **Maple Family** | | | | | |
| *Acer* | bigleaf maple | 1 | | | X | |
| **ADOXACEAE** | **Adoxa Family** | | | | | |
| *Sambucus* | Elderberry | 1 | Fr, Fl | X | X | X[2] |
| **AMARANTHACEAE** | **Amaranth Family** | | | | | |
| *Amaranthus* | pigweed | 2 | S, Gr | | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| **ANACARDIACEAE** | **Sumac Family** | | | | | |
| *Rhus* | lemonade berry | 2 | Fr, P | | X | X |
| *Toxicodendron* | poison oak | 1 | | X | X | X[2] |
| **APIACEAE** | **Carrot Family** | | | | | |
| *Apiastrum* | wild celery | 1 | Gr | | | |
| *Berula* | water parsnip | 1 | | | | |
| *Bowlesia* | bowlesia | 1 | | | | |
| *Daucus* | rattlesnake weed | 1 | Ge | X | | X |
| *Lomatium* | caraway-leaf lomatium | 1 | Ge, Gr | X | | X |
| *Sanicula* | snakeroot | 2 | Ge, Gr | | | |
| *Yabea* | California hedge-parsley | 1 | | | | |
| **ASCLEPIADACEAE** | **Milkweed Family** | | | | | |
| *Asclepias* | narrowleaf milkweed | 1 | Ge, Gr | X | X | X |
| **ASTERACEAE** | **Sunflower Family** | | | | | |
| *Achillea* | yarrow | 1 | | X | | X |
| *Achyrachaena* | blow-wives | 1 | S | | | |
| *Acourtia* | sacapellote | 1 | | X | | X |
| *Agoseris* | mountain dandelion | 1 | Gr | | | |
| *Amblyopappus* | pineapple weed | 1 | | | | |
| *Ambrosia* | beachbur | 1 | | | | |
| *Artemesia* | CA sage; mugwort | 2 | S | X | X | X[2] |
| *Aster* | aster | 3 | | | | |
| *Baccharis* | coyote brush; baccharis | 4 | | X | X | X |
| *Blennosperma* | stickyseeds | 1 | S | | | |
| *Brickellia* | California boneset | 1 | | | | |
| *Cirsium* | Indian thistle | 3 | W | | | X |
| *Conyza* | horseweed | 1 | | X | | X |
| *Encelia* | bush sunflower | 1 | Gr | | | |
| *Ericameria* | mock heather | 2 | | X | | X |
| *Erigeron* | fleabane | 4 | Gr | | | |
| *Eriophyllum* | golden yarrow | 2 | | X | | |
| *Filagro* | California filagro | 1 | | | | |
| *Gnaphalium* | everlasting; cudweed | 8 | | X | | X |
| *Grindelia* | gumplant | 2 | Gr | X | | X |
| *Hazardia* | island hazardia | 2 | | | | |
| *Helianthus* | common sunflower | 1 | S | | | |
| *Hemizonia* | tarweed | 5 | S, Gr | | X | X |
| *Heterotheca* | telegraph weed | 1 | | | X | X |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| *Hieracium* | hawkweed | 1 | | | | |
| *Isocoma* | goldenbush | 2 | | | | |
| *Jaumea* | fleshy jaumea | 1 | | | | |
| *Lasthenia* | goldfields | 1 | S | | | |
| *Layia* | tidytips | 1 | S | | | |
| *Lepidospartum* | scale broom | 1 | | | | |
| *Leptosyne* | giant coreopsis | 1 | S, St | | | |
| *Lessingia* | cudweed-aster | 2 | | | | |
| *Madia* | coast tarweed | 3 | S | | | |
| *Malacothris* | island chicory | 5 | S | | | |
| *Micropus* | slender cottonweed | 1 | | | | |
| *Microseris* | silver puffs | 2 | | | | |
| *Perityle* | Emory's rock daisy | 1 | | | | |
| *Pluchea* | salt marsh fleabane | 1 | | | | |
| *Psilocarphus* | slender woolly-heads | 1 | | | | |
| *Rafinesquia* | California chicory | 1 | W | | | |
| *Senecio* | groundsel | 2 | | X | | |
| *Solidago* | California goldenrod | 1 | Gr | X | | X |
| *Stebbinsoseris* | stebbinsoseris | 1 | | | | |
| *Stephanomeria* | milk-aster | 4 | | X | | |
| *Styocline* | everlasting nest-straw | 1 | | | | |
| *Uropappus* | silver puffs | 1 | | | | |
| *Venegasia* | canyon sunflower | 1 | | | | |
| *Xanthium* | cocklebur | 1 | | X | | X |
| **BERBERIDACEAE** | **Barberry Family** | | | | | |
| *Berberis* | island barberry | 1 | Fr | | | |
| **BORAGINACEAE** | **Forget-me-not Family** | | | | | |
| *Amsinkia* | fiddleneck | 3 | S, Gr | | | X |
| *Cryptantha* | cryptantha | 3 | S, Gr | | | |
| *Heliotropium* | heliotrope | 1 | S | | | |
| *Pectocarya* | slender comb-seed | 2 | | | | |
| *Phacelia* | phacelia | 5 | Gr | | | |
| *Pholistoma* | fiesta flower | 2 | Gr | | | |
| *Plagiobothrys* | popcorn flower | 3 | S | | | |
| **BRASSICACEAE** | **Mustard Family** | | | | | |
| *Arabis* | Hoffman's rock cress | 1 | | | | |
| *Athysanus* | sandweed | 1 | | | | |
| *Cardamine* | milk maids | 2 | Ge | | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| *Caulanthus* | California mustard | 1 | S, Gr | | | |
| *Descurainia* | tansy mustard | 1 | S, Gr | | | |
| *Draba* | whitlow-grass | 1 | | | | |
| *Erysimum* | island wallflower | 1 | | | | |
| *Hutchinsia* | hutchinsia | 1 | | | | |
| *Lepidium* | peppergrass | 4 | S, Gr | X | | X |
| *Nasturtium* | water cress | 1 | Gr | X | | X |
| *Sibara* | island rock cress | 1 | | | | |
| *Thysanocarpus* | lace pod | 3 | S | | | |
| **CACTACEAE** | **Cactus Family** | | | | | |
| *Opuntia* | prickly pear/cholla cactus | 3 | W | X | X | X |
| **CAMPANULACEAE** | **Bellflower Family** | | | | | |
| *Githopsis* | southern blue cup | 1 | | | | |
| *Triodanis* | Venus' looking glass | 1 | | | | |
| **CAPPARACEAE** | **Caper Family** | | | | | |
| *Peritoma* | bladderpod | 1 | Fl | | | |
| **CAPRIFOLIACEAE** | **Honeysuckle Family** | | | | | |
| *Lonicera* | honeysuckle | 3 | Fr | X | | X |
| *Symphoricarpos* | creeping snowberry | 1 | Fr | X | X | X |
| **CARYOPHYLLACEAE** | **Pink Family** | | | | | |
| *Cardionema* | sandmat | 1 | | | | |
| *Minuartia* | Douglas' sandwort | 1 | | | | |
| *Polycarpon* | California polycarpon | 1 | | | | |
| *Sagina* | pearlwort | 2 | | | | |
| *Silene* | Indian pink | 3 | | X | | X |
| *Spergularia* | sand spurrey | 2 | | | | |
| *Stellaria* | shining chickweed | 1 | | | | |
| **CHENOPODIACEAE** | **Goosefoot Family** | | | | | |
| *Aphanisma* | aphanisma | 1 | | | | |
| *Atriplex* | saltbush | 8 | S | X | | X |
| *Chenopodium* | Goosefoot | 2 | S, Gr | X | X | X |
| *Monolepis* | Nuttall’s povertyweed | 1 | S, Ge | | | |
| *Salicornia* | glasswort;pickleweed | 2 | S, Gr | | | |
| *Suaeda* | sea blite | 1 | S, Gr | | | |
| **CISTACEAE** | **Rockrose Family** | | | | | |
| *Helianthemum* | island rushrose | 2 | | | | |
| **CONVOLVULACEAE** | **Morning Glory Family** | | | | | |
| *Calystegia* | island morning glory | 2 | | X | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| *Convolvulus* | bindweed | 1 | | X | | |
| *Cressa* | alkali weed | 1 | | | | |
| *Dichondra* | western dichondra | 1 | | | | |
| **CRASSULACEAE** | **Stonecrop Family** | | | | | |
| *Crassula* | pygmy weed | 1 | | | | |
| *Dudleya* | dudleya, live-forever | 3 | Gr | | | |
| **CURCURBITACEAE** | **Gourd Family** | | | | | |
| *Curcurbita* | calabazilla | 1 | S | X | X | X |
| *Marah* | wild cucumber | 2 | | X | X | X |
| **CUSCUTACEAE** | **Dodder Family** | | | | | |
| *Cuscuta* | dodder | 2 | | X | | |
| **ERICACEAE** | **Heather Family** | | | | | |
| *Arbutus* | madrone | 1 | Fr | X | X | |
| *Arctostaphylos* | manzanita | 4 | Fr, P | X | X | X |
| *Comarostaphylis* | summer-holly | 1 | | | | |
| *Vaccinium* | California huckleberry | 1 | Fr | | | |
| **EUPHORBIACEAE** | **Spurge Family** | | | | | |
| *Croton* | dove weed | 1 | | X | X | X |
| *Euphorbia* | spurge | 2 | | X | | X |
| *Stillingia* | toothleaf | 1 | | | | |
| **FABACEAE** | **Bean Family** | | | | | |
| *Astragalus* | locoweed | 4 | | X | | |
| *Lathyrus* | wild sweet pea | 1 | S, Gr | | | |
| *Lotus* | lotus, deerweed | 9 | | X | X | |
| *Lupinus* | lupine | 8 | Ge, Gr[1] | | | |
| *Pickeringia* | chaparral pea | 1 | | | | |
| *Trifolium* | clover | 9 | S, Gr | | | X |
| *Vicia* | vetch | 3 | Gr | | | |
| **FAGACEAE** | **Oak Family** | | | | | |
| *Quercus* | oak | 10 | N[1] | | X | X[2] |
| **FRANKENIACEAE** | **Frankenia Family** | | | | | |
| *Frankenia* | alkali heath | 1 | | | | |
| **GARRYACEAE** | **Silk-tassel Family** | | | | | |
| *Garrya* | silk-tassel | 1 | | X | X | |
| **GENTIANACEAE** | **Gentian Family** | | | | | |
| *Centarium* | centaury | 1 | | X | | X |
| **GERANIACEAE** | **Geranium Family** | | | | | |
| *Geranium* | Carolina cranesbill | 1 | | X | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| **GROSSULARIACEAE** | **Gooseberry Family** | | | | | |
| *Ribes* | gooseberry | 2 | Fr | X | | |
| **HYDROPHYLLACEAE** | **Waterleaf Family** | | | | | |
| *Emmenanthe* | whispering bells | 1 | | | | |
| *Eucrypta* | hideseed | 1 | | | | |
| *Nemophila* | baby blue eyes | 1 | | | | |
| **LAMINACEAE** | **Mint Family** | | | | | |
| *Clinopodium* | yerba buena | 1 | Gr | X | | X |
| *Lepechinia* | pitcher sage | 1 | | X | | |
| *Salvia* | sage | 3 | S | X | | X |
| *Scutellaria* | skullcap | 1 | | X | | |
| *Stachys* | wood-mint | 1 | | X | | |
| **LOASACEAE** | **Blazing Star Family** | | | | | |
| *Mentzelia* | stickleaf | 2 | S | | | |
| **LYTHRACEAE** | **Loosestrife Family** | | | | | |
| *Lythrum* | loosestrife | 1 | | | X | |
| **MALVACEAE** | **Mallow Family** | | | | | |
| *Eremalche* | white mallow | 1 | | X | | |
| *Lavatera* | tree mallow | 2 | | | | |
| *Malacothamnus* | bush mallow | 1 | | X | X | X |
| *Sidalcea* | checker mallow | 1 | Gr | | | |
| **NYCTAGINACEAE** | **Four-o'clock Family** | | | | | |
| *Abronia* | verbena | 2 | Ge | | | |
| *Mirabilis* | wishbone bush | 1 | | X | | |
| **ONAGRACEAE** | **Evening Primrose Family** | | | | | |
| *Camissonia* | primrose | 7 | Gr | | | |
| *Clarkia* | clarkia | 3 | S | | | |
| *Epilobium* | California fuchsia | 5 | S | X | | X |
| *Ludwigia* | marsh purslane | 1 | | | | |
| *Oenothera* | evening primrose | 1 | | | | |
| **OROBANCHACEAE** | **Broomrape Family** | | | | | |
| *Orobanche* | broomrape | 4 | Ge | | | |
| *Castilleja* | owl clover, paintbrush | 5 | S | | | |
| **OXALIDACEAE** | **Wood-sorrel Family** | | | | | |
| *Oxalis* | California wood-sorrel | 1 | Ge, Gr | | | X |
| **PAPAVERACEAE** | **Poppy Family** | | | | | |
| *Dendromecon* | bush poppy | 1 | S | X | | |
| *Dicentra* | bleeding heart | 1 | | | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| *Eschscholzia* | California poppy | 2 | S, Gr | | | |
| *Meconella* | fairy poppy | 1 | | | | |
| *Papaver* | fire poppy | 1 | | | | |
| *Platystemon* | cream cups | 1 | Gr | | | |
| *Stylomecon* | wind poppy | 1 | | | | |
| **PHRYMACEAE** | **Lopseed Family** | | | | | |
| *Mimulus* | monkeyflower | 4 | Gr | X | | |
| **PLANTAGINACEAE** | **Plantain Family** | | | | | |
| *Plantago* | plantain | 2 | | X | | X |
| **PLANTANACEAE** | **Sycamore Family** | | | | | |
| *Platanus* | California sycamore | 1 | | X | X | X[2] |
| **POLEMONIACEAE** | **Phlox Family** | | | | | |
| *Eriastrum* | woollystar | 1 | | X | | |
| *Gilia* | gilia | 4 | S | | | |
| *Linanthus* | linanthus | 2 | | | | |
| *Navarretia* | pincushion plant | 1 | S | X | | |
| **POLYGALACEAE** | **Milkwort Family** | | | | | |
| *Polygala* | California milkwort | 1 | | X | | |
| **POLYGONACEAE** | **Buckwheat Family** | | | | | |
| *Chorizanthe* | spine flower | 1 | | | | |
| *Eriogonum* | buckwheat | 4 | S, Gr | X | | X |
| *Lastarriaea* | leather spineflower | 1 | | | | |
| *Polygonum* | smartweed | 1 | S | X | | |
| *Pterostegia* | fairy mist | 1 | | | | |
| *Rumex* | willow dock | 1 | S, Gr | X | X | X |
| **PORTULACACEAE** | **Purslane Family** | | | | | |
| *Calandrinia* | red maids | 3 | S | | | X |
| *Claytonia* | miner's lettuce | 3 | S, Gr | | | X |
| *Montia* | water chickweed | 1 | Gr | | | |
| **PRIMULACEAE** | **Primrose Family** | | | | | |
| *Dodecatheon* | shooting star | 1 | Ge, Gr | | | X |
| *Samolus* | water pimpernel | 1 | | | | |
| **RANUNCULACEAE** | **Buttercup Family** | | | | | |
| *Clematis* | clematis | 3 | | X | | X |
| *Delphinium* | Parry's Larkspur | 1 | Gr | | | |
| *Ranunculus* | California buttercup | 1 | S | | | |
| **RESEDACEAE** | **Mignonette Family** | | | | | |
| *Oligomeris* | oligomeris | 1 | | | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| **RHAMNACEAE** | **Buckthorn Family** | | | | | |
| *Ceanothus* | ceanothus, lilac | 3 | S | | X | X |
| *Rhamnus* | redberry, coffeeberry | 2 | | X | | X |
| **ROSACEAE** | **Rose Family** | | | | | |
| *Adenostoma* | chamise | 2 | | X | X | X |
| *Aphanes* | lady's mantle | 1 | | | | |
| *Cercocarpus* | mountain mohagany | 1 | | X | X | X |
| *Heteromeles* | toyon | 1 | Fr | | X | X[2] |
| *Holodiscus* | cream bush | 1 | | | X | |
| *Lyonothamnus* | SCI ironwood | 1 | | | X | X[2] |
| *Potentilla* | silverweed | 1 | | | | |
| *Prunus* | island cherry | 1 | Fr, P[1] | | | X[2] |
| *Rosa* | California wild rose | 1 | Fr, Fl | X | | X |
| *Rubus* | California blackberry | 1 | Fr | X | | X |
| **RUBIACEAE** | **Madder Family** | | | | | |
| *Galium* | bedstraw | 6 | | X | X | |
| **SALICAEAE** | **Willow Family** | | | | | |
| *Populus* | cottonwood | 2 | | X | X | X |
| *Salix* | willow | 4 | | X | X | X[2] |
| **SAURURACEAE** | **Lizard-tail Family** | | | | | |
| *Anemopsis* | yerba mansa | 1 | | X | | X |
| **SAXIFRAGACEAE** | **Saxifrage Family** | | | | | |
| *Heuchera* | island alum-root | 1 | Gr | | | |
| *Jepsonia* | island jepsonia | 1 | Ge | | | |
| *Lithophragma* | mission star | 1 | | X | | |
| *Micranthes* | California saxifrage | 1 | | | | |
| **SCROPHULARIACEAE** | **Figwort Family** | | | | | |
| *Antirrhinum* | snapdragon | 3 | | | | |
| *Keckiella* | climbing penstemon | 1 | | X | | X |
| *Linaria* | blue toadflax | 1 | | | | |
| **SOLANACEAE** | **Nightshade Family** | | | | | |
| *Datura* | Momoy, jimson weed | 1 | | X | | X[2] |
| *Lycium* | boxthorn | 1 | Fr | | | |
| *Nicotiana* | Cleaveland's tobacco | 1 | | X | | X |
| *Solanum* | island nightshade | 2 | Fr | X | X | X[2] |
| **URTICACEAE** | **Nettle Family** | | | | | |
| *Hesperocnide* | western nettle | 1 | | | | |
| *Parietaria* | western pellitory | 1 | | | | |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| *Urtica* | stinging nettle | 1 | Gr | X | X | X[2] |
| **VALERIANACEAE** | **Valerian Family** | | | | | |
| *Plectritis* | seablush | 1 | | | | |
| **VERBENACEAE** | **Vervain Family** | | | | | |
| *Verbena* | verbena | 1 | | X | | X |
| **VIOLACEAE** | **Violet Family** | | | | | |
| *Viola* | johnny jump up | 1 | Gr, Fl | | | |
| | | | | | | |
| ***Monocotyledonous Flowering Plants*** | | | | | | |
| **ALLIACEAE** | **Onion Family** | | | | | |
| *Allium* | onion | 2 | Ge, Gr | X | | X |
| **ARECACEAE** | **Palm Family** | | | | | |
| *Washingtonia* | fan palm | 1 | Fr | | X | |
| **CYPERACEAE** | **Sedge Family** | | | | | |
| *Carex* | sedge | 6 | Ge, St | | X | |
| *Isolepis* | California bulrush | 1 | Ge, S | | X | X[2] |
| *Schoenoplectus* | bulrush | 2 | Ge, S | | X | X[2] |
| **IRIDACEAE** | **Iris Family** | | | | | |
| *Sisyrinchium* | blue eyed grass | 1 | | X | | X |
| **JUNCACEAE** | **Rush Family** | | | | | |
| *Juncus* | rush | 4 | St | | X | X[2] |
| *Luzula* | common wood-rush | 1 | | | | |
| **LILIACEAE** | **Lily Family** | | | | | |
| *Calochortus* | mariposa lily | 3 | Ge | | | X |
| *Lilium* | Humboldt's lily | 1 | Ge | | | |
| **MELANTHIACEAE** | **False-Hellebore Family** | | | | | |
| *Toxicoscordion* | death-camas | 1 | Ge[1] | X | | X |
| **ORCHIDACEAE** | **Orchid Family** | | | | | |
| *Epipactis* | stream orchid | 1 | | | | |
| *Piperia* | rein orchid | 2 | Ge | | | |
| **POACEAE** | **Grass Family** | | | | | |
| *Achnatherum* | San Diego needlegrass | 1 | | | | |
| *Agrostis* | bentgrass | 2 | | | | |
| *Andropogon* | bushy beardgrass | 1 | | | | |
| *Aristida* | three awn | 1 | | | | |
| *Bromus* | brome | 4 | S | | | |
| *Calamagrostis* | pine grass | 1 | S | | | |
| *Distichlis* | saltgrass | 1 | Gr | X | | X |

| Genus | Common Name | # sp | Food | Medicine | Tool | Chumash* |
|---|---|---|---|---|---|---|
| *Elymus* | rye | 4 | S | X | X | X[2] |
| *Festuca* | fescue | 2 | S | | | |
| *Hordeum* | barley | 3 | S | | | |
| *Koeleria* | June grass | 1 | | | | |
| *Melica* | Coast Range melic | 1 | Ge, S | | | |
| *Muhlenbergia* | littleseed muhly | 1 | S | | X | X |
| *Paspalum* | knotgrass | 1 | | | | |
| *Poa* | bluegrass | 2 | S | | | |
| *Stipa* | needlegrass | 3 | S | | | |
| **POTAMOGETONACEAE** | **Pondweed Family** | | | | | |
| *Ruppia* | ditchgrass | 1 | | | | |
| *Stuckenia* | fennel-leaf pondweed | 1 | W | | X | |
| **THEMIDACEAE** | **Brodiaea Family** | | | | | |
| *Bloomeria* | golden stars | 1 | Ge | | X | |
| *Brodiaea* | dwarf brodiaea | 1 | Ge | | X | |
| *Dichelostemma* | blue dicks, wild hyacinth | 1 | Ge, Gr | | X | X |
| *Triteleia* | white triteleia | 1 | Ge | | | |
| **TYPHACEAE** | **Cattail Family** | | | | | |
| *Typha* | cattail | 2 | Ge, Po, S | | X | X |
| **ZANNICHELLIACEAE** | **Horned Pondweed Family** | | | | | |
| *Zannichellia* | horned pondweed | 1 | | | | |
| **ZOSTERACEAE** | **Eel-grass Family** | | | | | |
| *Phyllospadix* | surf-grass | 2 | | | X | X |
| *Zostera* | eel-grass | 2 | Ge | | | |

Table compiled from Anderson 2005, Junak et al. 1995, Mead 2003, Timbrook 2007. Notes: [1] Indicates toxicity that must be processed prior to consumption. [2] Indicates a recorded Island Chumash (Cruzeno) name. Edible Parts: Fl-Flower; Fr-Fruit; Ge-Geophyte; Gr-Greens; N-Nut; P-Pit; Po-Pollen; S-Seeds; St-Stem; W-Whole. * Not all uses indicated of a particular plant were recorded in the Chumash area, accounting for a discrepancy in total number shown in the table vs. text for food, medicine or tool use.

# APPENDIX B

RAW PALEOETHNOBOTANICAL DATA

Table B.1. Raw Paleoethnobotanical Data from Sunburst (CA-SCRI-813)

| **Stratum**<br>**Depth in cm**<br>**Volume (liters)** | | | **1**<br>**3-12 cm**<br>**3.25** | **2**<br>**12-22 cm**<br>**5.00** | **2/***<br>**22-39 cm**<br>**7.00** |
|---|---|---|---|---|---|
| **Time Period** | | | **Transitional-Late Period** | | |
| Taxon of Large Taxa | Common Name | | | | |
| *Arctostaphylos* spp. | Manzanita | n | 4 | 1 | 1 |
| | | g | 0.01 | <0.01 | 0.01 |
| *Brodiaea* s.l. | Brodiaea | n | -- | 3 | -- |
| | | g | -- | 0.01 | -- |
| *Marah* sp. | Wild Cucumber | n | 5 | 14 | 1 |
| | | g | 0.03 | 0.04 | 0.01 |
| *Quercus* spp. | Acorn | n | -- | 3 | -- |
| | | g | -- | <0.01 | -- |
| Wood Charcoal (2.0mm) | | g | 0.1 | 0.62 | 0.06 |
| Taxon of Small Taxa | Common Name | | | | |
| *Atriplex* spp. | Saltbush | n | -- | 1 | -- |
| *Claytonia* spp. | Miner's Lettuce | n | -- | 1 | -- |
| *Hypericum* spp. | Tinker's Penny | n | -- | 1 | -- |
| *Madia* spp. | Tarweed | n | -- | 2 | -- |
| *Phacelia* spp. | Phacelia | n | -- | 1 | 1 |
| *Rhus integrifolia* | Lemonade Berry | n | -- | 3 | 1 |
| *Salvia* spp. | Chia, Sage | n | -- | 9 | -- |
| *Trifolium* spp. | Clover | n | -- | -- | 1 |
| Asteraceae | Sunflower Family | n | -- | 2 | -- |
| Poaceae | Grass Family | n | -- | 2 | -- |
| Unidentified Seeds | | n | 16 | 4 | -- |
| Unidentified Seed Fragments | | n | 36 | 28 | 2 |
| Total Seeds Identified to Genus | | n | -- | 18 | 3 |
| Total Seeds Identified to Family | | n | -- | 4 | 2 |

Table B.2. Raw Paleoethnobotanical Data from Brodiaea Ridge (CA-SCRI-814)

| **Stratum** | | | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **0-6** | **6-16** | **16-27** | **27-35** | **35-39** |
| **Volume (liters)** | | | **3.00** | **4.75** | **5.50** | **4.50** | **1.75** |
| Large Taxa | | | | | | | |
| **Genus** | **Name** | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | 1 | 2 | -- | -- |
| | | g | -- | <0.01 | <0.01 | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | -- | 3 | 4 | 25 | -- |
| | | g | -- | 0.05 | 0.02 | 0.15 | -- |
| *Marah* | Wild Cucumber | n | -- | 1 | 1 | 2 | -- |
| | | g | -- | <0.01 | <0.01 | <0.01 | -- |
| *Quercus* | Acorn | n | -- | -- | 3 | -- | 1 |
| | | g | -- | -- | <0.01 | -- | <0.01 |
| UnID Nutshell | | n | 2 | -- | -- | -- | 1 |
| | | g | <0.01 | -- | -- | -- | <0.01 |
| Wood Charcoal (2.0 mm) | | g | 0.02 | 0.49 | 0.85 | 0.74 | 0.04 |
| Small Taxa | | | | | | | |
| **Taxon** | **Name** | | | | | | |
| *Berberis* sp. | Island Barberry | n | -- | -- | -- | 1 | -- |
| *Bromus* spp. | Brome Grass | n | -- | -- | 1 | -- | -- |
| *Eleocharis* sp. | Spikerush | n | -- | 1 | 1 | -- | -- |
| *Eriogonum* spp. | Buckwheat | n | -- | 1 | 3 | 2 | -- |
| *Galium* spp. | Bedstraw | n | -- | 2 | 1 | -- | -- |
| *Hemizonia* spp. | Tarweed | n | -- | 1 | 3 | 2 | -- |
| *Lotus scoparius* | Deerweed | n | -- | 1 | -- | -- | -- |
| *Peritoma* spp. | Bladderpod | n | -- | 1 | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | 1 | -- | -- | 1 |
| *Potamogeton* | Pondweed | n | -- | -- | -- | -- | 1 |
| *Rhus integrifolia* | Lemonade Berry | n | -- | -- | 1 | -- | -- |
| *Salvia* spp. | Chia, Sage | n | -- | 2 | 1 | -- | -- |
| *Sambucus* sp. | Elderberry | n | -- | -- | 1 | -- | -- |
| *Trifolium* spp. | Clover | n | -- | -- | 1 | 3 | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | -- | -- | -- | 1 |
| Fabaceae | Bean Family | n | -- | -- | -- | -- | 2 |
| Poaceae | Grass Family | n | 2 | 12 | 1 | -- | -- |
| Amorphous | | n | -- | 6 | -- | 10 | -- |
| | | g | -- | <0.01 | -- | <0.01 | -- |
| Unidentified Seeds | | n | 4 | 3 | 4 | 9 | 1 |
| Unidentified Seed Fragments | | n | -- | 18 | 22 | 16 | 8 |
| Total Seeds Identified to Genus | | n | -- | 10 | 13 | 7 | 2 |
| Total Seeds Identified to Family | | n | 2 | 12 | 1 | -- | 3 |

Table B.3a. Raw Paleoethnobotanical Data from Diablo Valdez, locus 2 (CA-SCRI-619/620)

| **Stratum** | | | **8A** | **8B** | **9** | **10A** | **10B** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **135-144** | **146-162** | **159-172** | **172-191** | **191-201** |
| **Feature** | | | | | **RP** | | |
| **Volume (liters)** | | | **3.00** | **5.75** | **1.25** | **7.25** | **2.50** |
| **Time Period** | | | **Early Period** | | | | |
| Scientific Name | Common Name | | | | | | |
| Large Taxa | | | | | | | |
| *Arctostaphylos* | Manzanita | n | 1 | 12 | -- | 1 | -- |
| | | g | 0.05 | 0.03 | -- | 0.005 | -- |
| Brodiaea s.l. | Brodiaea | n | 31 | 38 | 1 | 19 | 2 |
| | | g | 0.14 | 0.21 | 0.02 | 0.03 | <0.01 |
| *Marah* | Wild Cucumber | n | -- | -- | 1 | 3 | 5 |
| | | g | -- | -- | <0.01 | 0.01 | <0.01 |
| *Quercus* | Acorn Nutshell | n | -- | -- | 2 | 5 | -- |
| | | g | -- | -- | <0.01 | 0.01 | -- |
| | Acorn Cap | n | -- | 1 | -- | -- | -- |
| | | g | -- | 0.005 | -- | -- | -- |
| UnID Nutshell | | n | -- | 3 | -- | -- | -- |
| | | g | -- | 0.005 | -- | -- | -- |
| Wood Charcoal | | g | 1.88 | 2.78 | 0.11 | 0.43 | 0.11 |
| Small Taxa | | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | 1 | -- | -- | -- |
| *Atriplex* spp. | Saltbush | n | 1 | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | -- | -- | -- | -- | -- |
| *Chenopodium* spp. | Goosefoot | n | 1 | -- | -- | -- | -- |
| *Eriogonum* spp. | Buckwheat | n | -- | -- | -- | -- | -- |
| *Euphorbia* spp. | Spurge | n | -- | -- | -- | -- | -- |
| *Hypericum* spp. | Tinker's Penny | n | -- | -- | -- | -- | 1 |
| *Phacelia* spp. | Phacelia | n | 1 | 5 | -- | -- | -- |
| *Poa* spp. | Blue Grass | n | 1 | -- | -- | -- | -- |
| *Ruppia* spp. | Ditchgrass | n | -- | -- | -- | -- | -- |
| *Salvia* spp. | Chia, Sage | n | 1 | -- | -- | -- | -- |
| *Sisyrinchium* spp. | Blue Eyed Grass | n | -- | -- | -- | -- | -- |
| Asteraceae | Sunflower Family | n | -- | 1 | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | 8 | -- | 2 | -- |
| Fabaceae | Bean Family | n | 2 | 3 | -- | -- | -- |
| Poaceae | Grass Family | n | 2 | 11 | 6 | -- | -- |
| Amorphous | | n | 5 | 5 | 4 | 18 | 1 |
| | | g | 0.04 | 0.005 | -- | 0.01 | <0.01 |
| Centrospermae | | n | 3 | 2 | 1 | -- | -- |
| Unidentified Seeds | | n | -- | 1 | 3 | 1 | 3 |
| Unidentified Seed Fragments | | n | 17 | 8 | -- | 2 | -- |
| Total Seeds Identified to Genus | | n | 5 | 6 | -- | -- | 1 |
| Total Seeds Identified to Family | | n | 4 | 23 | 6 | 2 | -- |

Table B.3b. Raw Paleoethnobotanical Data from Diablo Valdez, locus 2 (CA-SCRI-619/620)

| **Stratum** | | | **4A** | **5** | **6A** | **6B** | **7** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **80-90** | **90-109** | **109-115** | **115-130** | **130-135** |
| **Feature** | | | | | | | **RP[2]** |
| **Volume (liters)** | | | **5.75** | **6.75** | **2.00** | **6.25** | **2.125** |
| **Time Period** | | | **Early Period** | | | | |
| Scientific Name | Common Name | | | | | | |
| Large Taxa | | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 40 | 22 | 14 | 20 | 3 |
| | | g | 0.39 | 0.12 | 0.01 | 0.24 | <0.01 |
| *Marah* | Wild Cucumber | n | 2 | -- | -- | 1 | -- |
| | | g | <0.01 | -- | -- | <0.01 | -- |
| *Quercus* | Acorn Nutshell | n | -- | 3 | -- | -- | -- |
| | | g | -- | 0.02 | -- | --- | -- |
| | Acorn Cap | n | -- | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- | -- |
| UnID Nutshell | | n | -- | -- | -- | -- | 2 |
| | | g | -- | -- | -- | -- | 0.01 |
| Wood Charcoal | | g | 6.42 | 3.16 | 0.29 | 1.68 | 1.94 |
| Small Taxa | | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | -- | -- | -- | -- |
| *Atriplex* spp. | Saltbush | n | -- | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | 1 | -- | 1 | -- | -- |
| *Chenopodium* spp. | Goosefoot | n | -- | -- | 1 | 2 | -- |
| *Eriogonum* spp. | Buckwheat | n | -- | -- | -- | 4 | -- |
| *Euphorbia* spp. | Spurge | n | -- | 1 | -- | -- | -- |
| *Hypericum* spp. | Tinker's Penny | n | -- | -- | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | -- | -- | 5 | 1 |
| *Poa* spp. | Blue Grass | n | -- | -- | -- | -- | -- |
| *Ruppia* spp. | Ditchgrass | n | -- | -- | -- | -- | 2 |
| *Salvia* spp. | Chia, Sage | n | -- | -- | -- | -- | -- |
| *Sisyrinchium* spp. | Blue Eyed Grass | n | -- | 1 | -- | -- | -- |
| Asteraceae | Sunflower Family | n | -- | -- | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | 9 | -- | -- | 5 |
| Fabaceae | Bean Family | n | 1 | -- | -- | -- | -- |
| Poaceae | Grass Family | n | -- | 1 | -- | 1 | 1 |
| Amorphous | | n | -- | 34 | 2 | 21 | 3 |
| | | g | -- | 0.04 | -- | 0.03 | <0.01 |
| Centrospermae | | n | -- | -- | -- | 1 | 1 |
| Unidentified Seeds | | n | -- | 1 | -- | -- | 1 |
| Unidentified Seed Fragments | | n | 2 | 6 | 1 | 18 | -- |
| Total Seeds Identified to Genus | | n | 1 | 2 | 2 | 11 | 3 |
| Total Seeds Identified to Family | | n | 1 | 10 | -- | 1 | 6 |

Table B.3c. Raw Paleoethnobotanical Data from Diablo Valdez, locus 2 (CA-SCRI-619/620)

| **Stratum** | | | **2H** | **3A** | **3B** | **3C** | **3D** | **3E** |
|---|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | | **38-53** | **50-55** | **55-61** | **61-69** | **69-80** |
| **Feature** | | | **HF [1]** | | | | | |
| **Volume (liters)** | | | **0.50** | **3.75** | **0.75** | **2.50** | **2.25** | **5.25** |
| **Time Period** | | | **Late Early Period** | | | | | |
| Scientific Name | Common Name | | | | | | | |
| Large Taxa | | | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | 2 | 2 | -- | 1 | -- |
| | | g | -- | 0.02 | 0.01 | -- | <0.01 | -- |
| *Brodiaea* s.l. | Brodiaea | n | 6 | 3 | 8 | -- | 13 | 24 |
| | | g | 0.04 | 0.01 | 0.02 | -- | 0.03 | 0.09 |
| *Marah* | Wild Cucumber | n | -- | 1 | -- | -- | 7 | 6 |
| | | g | -- | <0.01 | -- | -- | 0.02 | 0.01 |
| UnID Nutshell | | n | -- | -- | -- | -- | 4 | -- |
| | | g | -- | -- | -- | -- | <0.01 | -- |
| Wood Charcoal (2.0mm) | | g | 0.09 | 3.88 | 0.49 | 7.85 | 3.48 | 1.67 |
| Small Taxa | | | | | | | | |
| *Atriplex* spp. | Saltbush | n | -- | 1 | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | -- | 3 | 2 | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | 2 | -- | -- | -- | -- |
| *Poa* spp. | Blue Grass | n | -- | 1 | -- | -- | -- | -- |
| *Potamogeton* spp. | Pondweed | n | -- | 2 | -- | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | -- | 1 | 1 | -- | -- |
| Poaceae | Grass Family | n | -- | -- | 1 | -- | -- | 1 |
| Amorphous | | n | -- | 1 | 6 | -- | 5 | 6 |
| | | g | -- | <0.01 | 0.04 | -- | 0.01 | 0.04 |
| UnID Plant Tissue | | n | 3 | -- | -- | -- | -- | -- |
| | | g | 0.01 | -- | -- | -- | -- | -- |
| Centrospermae | | n | -- | 1 | -- | -- | -- | -- |
| Unidentified Seeds | | n | -- | -- | -- | -- | -- | -- |
| Unidentified Seed Fragments | | n | -- | -- | 1 | -- | -- | 1 |
| Total Seeds Identified to Genus | | n | -- | 9 | 2 | -- | -- | -- |
| Total Seeds Identified to Family | | n | -- | -- | 2 | 1 | -- | 1 |

Table B.3d. Raw Paleoethnobotanical Data from Diablo Valdez, locus 2 (CA-SCRI-619/620)

| **Stratum** | | | **1** | **2B-1** | **2B** |
|---|---|---|---|---|---|
| **Depth in cm** | | | **0-16** | | **16-36** |
| **Feature** | | | | **Pit** | **Pit** |
| **Volume (liters)** | | | **7.00** | **4.75** | **7.250** |
| **Time Period** | | | **Late Period** | | |
| Scientific Name | Common Name | | | | |
| Large Taxa | | | | | |
| *Arctostaphylos* spp. | Manzanita | n | 3 | 121 | 17 |
| | | g | 0.05 | 1.03 | 0.17 |
| *Brodiaea* s.l. | Brodiaea | n | 2 | 15 | 340 |
| | | g | <0.01 | 0.09 | 1.13 |
| *Marah* sp. | Wild Cucumber | n | 21 | 2 | 3 |
| | | g | 0.01 | <0.01 | <0.01 |
| *Quercus* spp. | Acorn Nutshell | n | 3 | 10 | 7 |
| | | g | <0.01 | 0.01 | 0.025 |
| UnID Nutshell | | n | -- | -- | 42 |
| | | g | -- | -- | 0.035 |
| Wood Charcoal | | g | 88.79 | 13.55 | 25.9 |
| Small Taxa | | | | | |
| *Achillea* sp. | Yarrow | n | -- | -- | 4 |
| *Atriplex* spp. | Saltbush | n | -- | -- | 10 |
| *Calandrinia* spp. | Red Maids | n | -- | -- | 24 |
| *Chenopodium* spp. | Goosefoot | n | -- | 26 | 8 |
| *Claytonia* spp. | Miners Lettuce | n | -- | -- | 4 |
| *Dendromecon* spp. | Bush Poppy | n | -- | -- | 6 |
| *Eriogonum* spp. | Buckwheat | n | -- | -- | 7 |
| *Hemizonia* spp. | Tarweed | n | -- | -- | 4 |
| *Lotus scoparius* | Deerweed | n | -- | 2 | -- |
| *Lepidium* spp. | Peppergrass | n | -- | -- | 4 |
| *Morella californica* | Wax Myrtle | n | -- | 3 | -- |
| *Phacelia* spp. | Phacelia | n | -- | 3 | 9 |
| *Potamogeton* spp. | Pondweed | n | -- | -- | 2 |
| *Silene* spp. | Catchfly | n | 8 | -- | -- |
| *Trifolium* spp. | Clover | n | -- | -- | 8 |
| Asteraceae | Sunflower Family | n | -- | 1 | -- |
| Chenopodiaceae | Goosefoot Family | n | -- | 1 | 8 |
| Fabaceae | Bean Family | n | -- | -- | 2 |
| Poaceae | Grass Family | n | 8 | 3 | 108 |
| Amorphous | | n | -- | -- | 13 |
| | | g | -- | -- | 0.3 |
| Unidentified Plant Tissue | | n | -- | -- | 7 |
| | | g | -- | -- | 0.11 |
| Centrospermae | | n | -- | 3 | -- |
| Unidentified Seeds | | n | 4 | 17 | 53 |
| Unidentified Seed Fragments | | n | 4 | 11 | 66 |
| Total Seeds Identified to Genus | | n | 8 | 34 | 90 |
| Total Seeds Identified to Family | | n | 8 | 5 | 118 |

Table B.4a. Raw Paleoethnobotanical Data from Diablo Valdez, locus 3 (CA-SCRI-619/620)

| **Stratum** | | | **9** | **10A** | **10B** | **11** | **12** |
|---|---|---|---|---|---|---|---|
| **Depth in cm** | | | **112-120** | **120-125** | **125-132** | **132-149** | **149-166** |
| **Volume (liters)** | | | **4.75** | **2.25** | **4.00** | **4.50** | **6.00** |
| **Time Period** | | | **Early Period** | | | | |
| Scientific Name | Common Name | | | | | | |
| Large Taxa | | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | 1 | -- | -- | -- |
| | | g | -- | 0.01 | -- | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 8 | 21 | 42 | 19 | 20 |
| | | g | 0.02 | 0.04 | 0.12 | 0.05 | 0.06 |
| *Marah* | Wild Cucumber | n | -- | -- | 4 | 1 | 1 |
| | | g | -- | -- | 0.01 | 0.01 | 0.01 |
| *Quercus* | Acorn | n | -- | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- | -- |
| UnID Nutshell | | n | -- | -- | -- | 2 | -- |
| | | g | -- | -- | -- | 0.01 | -- |
| Wood Charcoal | | g | 0.3 | 0.55 | 2.61 | 0.61 | 0.97 |
| Small Taxa | | | | | | | |
| *Euphorbia* spp. | Spurge | n | 1 | -- | -- | -- | -- |
| *Heliotropium* sp. | Sea Heliotrope | n | -- | -- | -- | -- | 1 |
| *Hypericum* spp. | Tinker's Penny | n | -- | -- | -- | -- | 1 |
| *Rhus integrifolia* | Lemonade Berry | n | -- | -- | -- | -- | 1 |
| *Trifolium* spp. | Clover | n | -- | -- | -- | -- | 1 |
| Fabaceae | Bean Family | n | -- | -- | -- | 2 | -- |
| Poaceae | Grass Family | n | -- | 1 | 1 | -- | -- |
| Solanaceae | Nightshade Family | n | 1 | -- | -- | -- | -- |
| Amorphous | | n | -- | 2 | -- | -- | -- |
| | | g | -- | <0.01 | -- | -- | -- |
| Centrospermae | | n | 1 | -- | -- | -- | -- |
| Unidentified Seeds | | n | 2 | -- | -- | 3 | 9 |
| Unidentified Seed Fragments | | n | -- | 10 | -- | -- | 10 |
| Total Identified to Genus | | n | 1 | -- | -- | -- | 4 |
| Total Identified to Family | | n | 1 | 1 | 1 | 2 | -- |

Table B.4b. Raw Paleoethnobotanical Data from Diablo Valdez, locus 3 (CA-SCRI-619/620)

| **Stratum** | | | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|
| **Depth in cm** | | | **60-71** | **71-83** | **83-87** | **87-112** |
| **Volume (liters)** | | | **4.00** | **5.00** | **1.75** | **5.75** |
| **Time Period** | | | **Late Early Period** | | | |
| Scientific Name | Common Name | | | | | |
| Large Taxa | | | | | | |
| *Arctostaphylos* | Manzanita | n | -- | -- | -- | -- |
| | | g | -- | -- | -- | -- |
| *Brodiaea* s.l. | Brodiaea | n | 8 | 53 | 10 | 21 |
| | | g | 0.02 | 0.2 | 0.05 | 0.1 |
| *Marah* | Wild Cucumber | n | 2 | 16 | 3 | 8 |
| | | g | 0.01 | 0.04 | 0.01 | 0.02 |
| *Quercus* | Acorn | n | -- | 2 | -- | -- |
| | | g | -- | 0.01 | -- | -- |
| UnID Nutshell | | n | 1 | -- | 2 | 5 |
| | | g | 0.01 | -- | 0.01 | 0.01 |
| Wood Charcoal | | g | 8.25 | 12.14 | 0.85 | 3.07 |
| Small Taxa | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | -- | -- | -- |
| *Aphanes occidentalis* | Lady's Mantle | n | -- | -- | -- | -- |
| *Calandrinia* spp. | Red Maids | n | 2 | -- | -- | -- |
| *Chenopodium* spp. | Goosefoot | n | -- | 1 | -- | 1 |
| *Euphorbia* spp. | Spurge | n | -- | -- | -- | -- |
| *Galium* spp. | Bedstraw | n | -- | -- | -- | -- |
| *Phacelia* spp. | Phacelia | n | -- | -- | -- | -- |
| *Phalaris* spp. | Canary Grass | n | -- | 1 | 1 | -- |
| *Poa* spp. | Blue Grass | n | 1 | -- | -- | -- |
| *Potamogeton* spp. | Pondweed | n | -- | -- | -- | -- |
| *Salvia* spp. | Chia, Sage | n | -- | -- | -- | 1 |
| Chenopodiaceae | Goosefoot Family | n | -- | -- | 1 | -- |
| Fabaceae | Bean Family | n | -- | -- | -- | 1 |
| Malvaceae | Mallow Family | n | -- | 1 | -- | -- |
| Poaceae | Grass Family | n | 1 | -- | -- | -- |
| Amorphous | | n | 2 | -- | -- | -- |
| | | g | <0.01 | -- | -- | -- |
| Centrospermae | | n | -- | -- | 1 | -- |
| Unidentified Seeds | | n | 12 | 6 | -- | 4 |
| Unidentified Seed Fragments | | n | 7 | 3 | -- | -- |
| Total Identified to Genus | | n | 3 | 2 | 1 | 2 |
| Total Identified to Family | | n | 1 | 1 | 1 | 1 |

Table B.4c. Raw Paleoethnobotanical Data from Diablo Valdez, locus 3 (CA-SCRI-619/620)

| **Stratum** | | | **2** | **3** | **3** | **4** |
|---|---|---|---|---|---|---|
| **Depth in cm** | | | **34-43** | **43-49** | **49-60** | **45-60** |
| **Volume (liters)** | | | **3.50** | **3.25** | **4.75** | **0.75** |
| **Time Period** | | | **Middle** | **Late Early** | | |
| Scientific Name | Common Name | | | | | |
| Large Taxa | | | | | | |
| *Arctostaphylos* spp. | Manzanita | n | -- | 1 | 1 | -- |
| | | g | -- | 0.01 | 0.01 | -- |
| *Brodiaea* s.l. | Brodiaea | n | 1 | 18 | 44 | 18 |
| | | g | 0.02 | 0.16 | 0.15 | 0.01 |
| *Marah* | Wild Cucumber | n | 1 | 3 | 15 | 2 |
| | | g | 0.01 | 0.01 | 0.03 | 0.01 |
| *Quercus* | Acorn | n | -- | 12 | 7 | -- |
| | | g | -- | 0.01 | 0.01 | -- |
| UnID Nutshell | | n | -- | -- | 1 | -- |
| | | g | -- | -- | 0.01 | -- |
| Wood Charcoal | | g | 3.65 | 4.8 | 9.08 | 1.87 |
| Small Taxa | | | | | | |
| *Adenostoma* sp. | Chamise | n | -- | -- | -- | 1 |
| *Aphanes occidentalis* | Lady's Mantle | n | -- | 2 | -- | -- |
| *Calandrinia* spp. | Red Maids | n | 2 | -- | 9 | -- |
| *Chenopodium* spp. | Goosefoot | n | -- | -- | -- | -- |
| *Claytonia* spp. | Miner's Lettuce | n | 2 | -- | -- | -- |
| *Euphorbia* spp. | Spurge | n | -- | 1 | -- | -- |
| *Galium* spp. | Bedstraw | n | -- | -- | 1 | -- |
| *Phacelia* spp. | Phacelia | n | -- | -- | 1 | 1 |
| *Phalaris* spp. | Canary Grass | n | 2 | -- | 3 | -- |
| *Poa* spp. | Blue Grass | n | -- | -- | -- | -- |
| *Potamogeton* spp. | Pondweed | n | -- | 1 | -- | -- |
| *Salvia* spp. | Chia, Sage | n | -- | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | 41 | 5 | 8 | -- |
| Fabaceae | Bean Family | n | -- | -- | -- | -- |
| Malvaceae | Mallow Family | n | -- | -- | -- | -- |
| Poaceae | Grass Family | n | 12 | 2 | 2 | -- |
| Amorphous | | n | 5 | 3 | 11 | 34 |
| | | g | 0.04 | <0.01 | <0.01 | 0.02 |
| Centrospermae | | n | 20 | -- | -- | -- |
| UnID Seeds | | n | 12 | 3 | 1 | 1 |
| UnID Seed Fragments | | n | 16 | 11 | 26 | -- |
| Total Identified to Genus | | n | 6 | 4 | 14 | 2 |
| Total Identified to Family | | n | 53 | 7 | 10 | -- |

Table B.4d. Raw Paleoethnobotanical Data from Diablo Valdez, locus 3 (CA-SCRI-619/620)

| **Stratum** | | | **1** | **1** | **1** | **1A** |
|---|---|---|---|---|---|---|
| **Depth in cm** | | | **0-17** | **14-24** | **24-34** | **16-27** |
| **Volume (liters)** | | | **6.00** | **2.00** | **4.00** | **1.25** |
| **Time Period** | | | **Late/Transitional** | | | |
| Scientific Name | Common Name | | | | | |
| Large Taxa | | | | | | |
| *Arctostaphylos* | Manzanita | n | 1 | -- | -- | 1 |
| | | g | 0.01 | -- | -- | 0.01 |
| *Brodiaea* s.l. | Brodiaea | n | 3 | 1 | 24 | 8 |
| | | g | 0.3 | 0.01 | 0.08 | 0.02 |
| *Marah* | Wild Cucumber | n | 4 | -- | 5 | -- |
| | | g | 0.01 | -- | 0.01 | -- |
| *Quercus* | Acorn | n | 22 | 2 | 2 | 3 |
| | | g | 0.02 | 0.01 | 0.01 | 0.01 |
| Wood Charcoal | | g | 3.4 | 1.76 | 6.53 | 0.48 |
| Small Taxa | | | | | | |
| *Bromus* spp. | Brome Grass | n | -- | -- | -- | 2 |
| *Claytonia* sp. | Miner's Lettuce | n | 4 | -- | -- | -- |
| *Phalaris* spp. | Canary Grass | n | -- | -- | -- | 1 |
| *Sambucus* sp. | Elderberry | n | -- | -- | 2 | -- |
| *Silene* spp. | Catchfly | n | 16 | -- | -- | -- |
| Chenopodiaceae | Goosefoot Family | n | 12 | 2 | 6 | 1 |
| Fabaceae | Bean Family | n | -- | -- | -- | 1 |
| Poaceae | Grass Family | n | 4 | 2 | 2 | 1 |
| Amorphous | | n | 18 | -- | 4 | -- |
| | | g | 0.03 | -- | 0.01 | -- |
| Centrospermae | | n | 4 | -- | 1 | -- |
| Unidentified Seeds | | n | 52 | 1 | 1 | 4 |
| Unidentified Seed Fragments | | n | 1 | 2 | 8 | 4 |
| Total Identified to Genus | | n | 20 | -- | 2 | 3 |
| Total identified to Family | | n | 16 | 4 | 8 | 3 |